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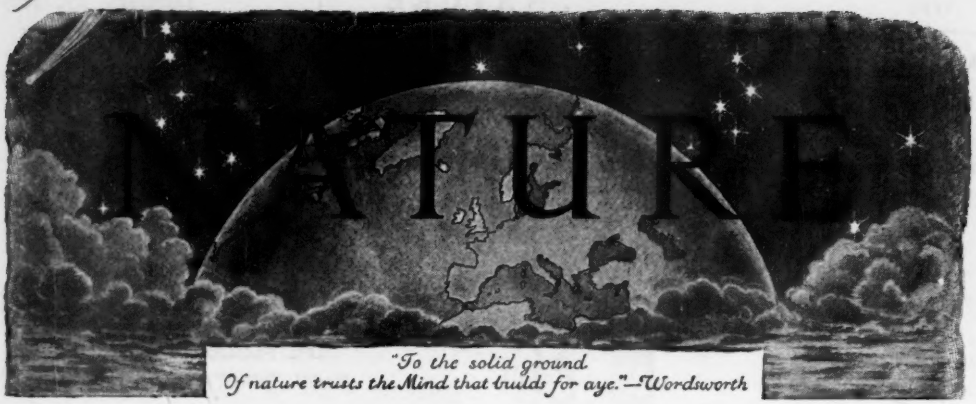

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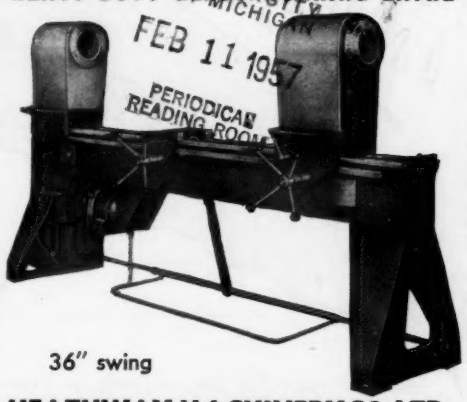

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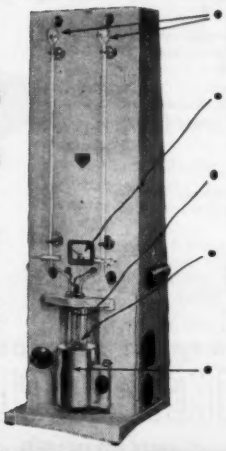

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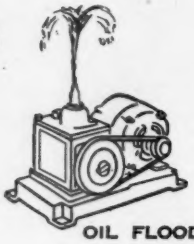

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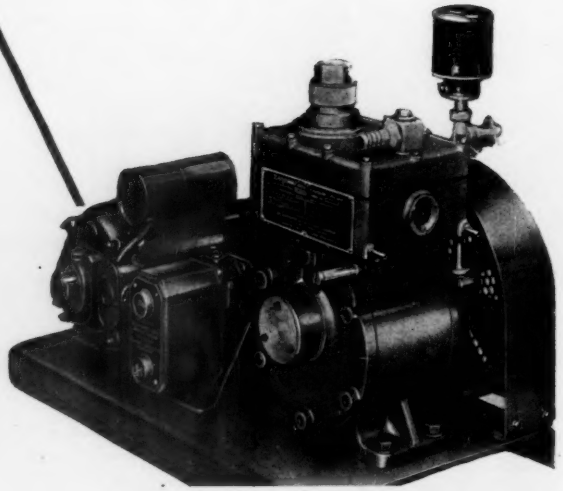

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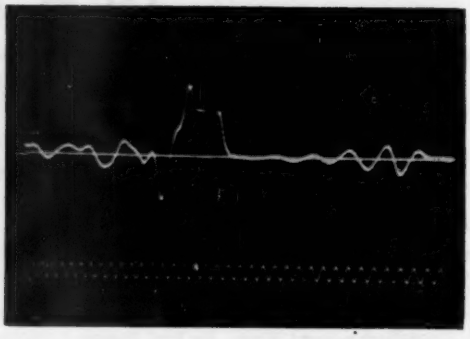

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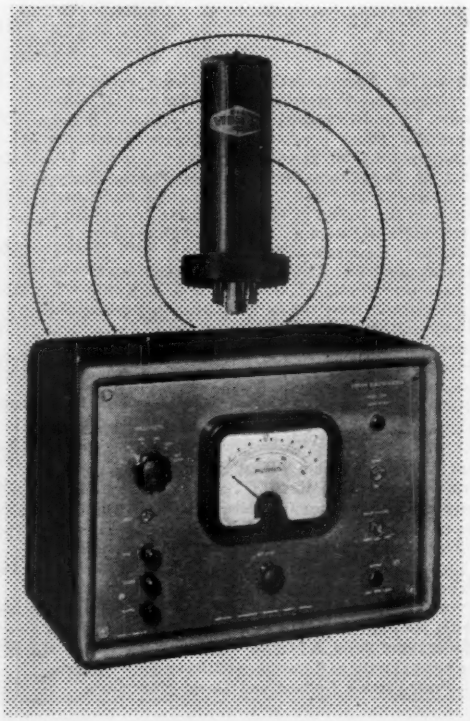

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PROBLEMS OF WORLD PRODUCTIVITY

IN his farewell report as president of the Carnegie Institution of Washington, Dr. Vannevar Bush, looking at the problems in physical and biological science still awaiting solution, emphasized the certainty of disaster unless man uses his resources and existing knowledge with much greater wisdom. Resources are being used up at an appalling rate, he said, and the demand on them is growing exponentially, and, apart altogether from the question whether we can succeed in avoiding world war, the world's population is increasing at a rate which renders distress, famine and disintegration inevitable unless we learn to hold our numbers within reason. We can, he thought, go far in providing new means of sustenance for great masses of people. The cultivation of the sea, for example, could yield richly if we learnt to control organisms and species, and the land is far from exhausted if we use it well. An understanding of photosynthesis could unlock stores of vital materials beyond our present power to envisage, and the control and training of natural species and the creation of new species at will for explicit purposes, especially species of lower organisms, holds enormous possibilities. Despite certain anxieties over our mineral resources, on the whole, with the coming of nuclear power and the prospect of solar energy, we can, Dr. Bush believes, probably meet our demands for energy for a long time to come.

So far, however, as food supply is concerned, the new methods can only postpone the crisis, and all depends on whether the interval is used with vision and energy in the task of education so as to promote the general understanding that is the key to a sound solution of the fundamental problem. There is as yet little evidence that this task is being undertaken with the urgency and imagination that are imperative. On the contrary, the channels of communication are often inadequate and blocked by lack of realism, and sometimes deliberately obstructed. Dr. Bush was concerned to summon his colleagues to that task as citizens rather than as scientists; though urging them to assist with their counsel in the fields within their professional competence so far as lay within their power, and to seek to extend the scientific approach to practical problems.

It is not surprising, therefore, that the fourth instalment of the symposium on "Science and the Affairs of Man" now appearing in the *Bulletin of the Atomic Scientists* should be devoted to "Science and World Economy", or that the second article in that symposium should be entitled "The Population Bomb". In that article, Dr. R. C. Cook, quoting from Dr. Bush's valedictory report, urges that a general understanding of the relation between population and food supply must precede a realistic and effective attack on the main problem. Failing that, falling death-rates through man's increasing control of disease will only result in an upsurge of population which will far outrun the food supply and frustrate all the hopes of the Colombo Plan, the Fourth Point Programme and other measures for bringing technical help to the backward and impoverished areas of the world. The future of the world economy hinges more crucially than most people realize on the rate of growth in education and general understanding, particularly of the two great dangers, nuclear war and a run-away growth in population.

Of these two dangers, Dr. Cook regards the population problem as probably the more difficult. The emotional and moral connotations with which the subject bristles greatly increase the difficulties of communication and education; but like the nuclear bomb, it is a by-product of scientific discovery, and all scientists have a responsibility to assist in the promotion of effective understanding both in human biology and in nuclear physics. He suggests that the concept of cybernetics advanced by Dr. Norbert Weiner, of the Massachusetts Institute of Technology, may be a fundamental step to meet the great need. A further step might be the development of social cybernetics, forecasting the obstacles and points of no return and promoting the kind of understanding that would permit effective action.

In the fourth article of this symposium, "Science and Hunger", Lord Boyd Orr looks again at the food problem, but strictly from the point of view of the power of science to increase food production. Lord Boyd Orr believes that the limit to food production is neither lack of knowledge nor physical obstacles of soil or climate, but is imposed by economic factors; and that the world food supply could be increased to support a larger population than the Earth is likely to carry in the near future. With modern science, the only practical limit to food production is the amount of capital and labour which governments are willing to devote to it. Thus he thinks the problem is political, and in characterizing the present period of conflict as the most rapid transitional phase that has ever occurred in the evolution of our civilization, Lord Boyd Orr suggests that an important step toward a peaceful and prosperous nuclear age would be the co-operation of all nations in applying science to the development of the resources of the Earth.

Such co-operation is in essence political, no matter how large a technical contribution the scientist and technologist may make; and the particular suggestion which Lord Orr makes to help mankind to get through this critical transition phase demands political action and a high degree of public understanding. A proposal that all nations should reduce their defence budget by, say, ten per cent, and devote half the savings to a reduction in taxation and the other half to the development, by an inter-

national authority under the supervision of the United Nations Assembly, of the potential resources of the Earth beginning with food, demands not merely good will but also political foresight, understanding and authority. Unhappily, recent events have made it only too plain that the United Nations is very far from possessing such properties. It is ignoring the practical difficulties with which the proposal bristles to assert that any nation which refused to co-operate in this way could no longer pretend that its political ideology was designed to promote the welfare of all mankind.

The difficulty is indeed the deeper one of public understanding, of varying standards and values; and until these are removed by widespread education, and there is something approaching a general standard of honesty, disinterested service, loyalty and respect for obligations, there is little hope of checking the inflamed nationalism that is mainly responsible to-day for denying mankind the benefits that science and technology offer. Prof. Harrison Brown in his article "A Changed and Changing World" does not discuss this aspect in questioning the sufficiency of the world resources to provide adequate living standards, though on it depends ultimately the validity of the assumption that the new technology can be transmitted. If we are willing to take the long view rather than the day-to-day short one, and to face the future squarely, applying our imagination and genius to the problems with which science and technology confront us, he believes there is a finite chance that we will leave our children a world which is at least as habitable as that we inherited from our parents.

Prof. Brown is manifestly doubtful as to the outcome of some of the future patterns of development, however fully we take advantage of nuclear power and other advances. Increasing competition and the pressure which the industrialized areas will experience may result in the progressive deterioration and destruction of democratic institutions rather than in the co-operation which Lord Boyd Orr urges, and the international control essential for survival. Dr. Alvin Weinberg, dealing und the title "To-day's Revolution" with the place of civilian nuclear power in public affairs, is alone more confident. He looks to nuclear energy, especially through the development of research reactors of low cost which will not only help to meet energy needs where they are most acute but at the same time encourage the development of a scientific tradition in areas where none exists, to assist decisively in raising the standard of living to a point where acquisition of the necessities of life is no longer the major occupation of most of mankind.

If that were achieved, the economic tensions and contradictions which have contributed so largely to wars would, as he suggests, undoubtedly be drastically lessened; but there is little in the opening survey of the symposium by Prof. W. A. Lewis on ten years of economic growth to warrant much optimism; nor have recent events in the Middle East improved the prospects for the development of a programme of technical and economic aid from the rich to the poorer countries which Prof. Lewis suggests may be the most significant feature of the next ten years. Moreover, Prof. F. Benham, in two essays, "The Colombo Plan: an Economic Survey" and "Over-population", in his little volume "The Colombo Plan"*, arrives at much the same conclusions as Dr. Vannevar Bush and Dr. Cook, and while he is emphatic that with the continuous growth of population something like the Colombo Plan was imperative, he is no less emphatic that the countries of the area will need to make great efforts to help themselves. There is no room for the partisanship which refuses to face facts and creates animosities and misunderstandings, and makes self-help and external aid alike difficult.

Prof. Benham's appraisal of the Colombo Plan does not overlook the fact that this co-operative endeavour, even on the external side, could well be bigger. It could be argued, he agrees, that the amount of technical assistance provided so far should be considerably increased; but the most expensive and perhaps the most urgent task is that of spreading knowledge of improved methods among the many millions of peasant cultivators, and inducing them to abandon their age-old practices in favour of more modern and suitable methods, but not necessarily methods demanding more capital. To make any significant impact upon apathy and ignorance, however, involves intensive propaganda to stir up the population to help themselves. Prof. Benham concludes that with a little planning, most countries in the area could absorb substantially more external aid than they are now receiving; but he stresses chiefly their need for great efforts themselves towards the widespread adoption of improved methods, especially in agriculture, and by using their own under-employed labour for community projects and similar schemes. More saving is required, including more taxation and in some countries higher charges for transport, electricity, irrigation water and similar services.

This need for greater self-effort in the backward and under-developed countries is reiterated in the other essays, notably in that on protection and the under-developed countries, where Prof. Benham points out that the only way in which such countries can hope to achieve a lasting and progressive rise in their standards of living is to raise their output per worker, especially in agriculture, and lay firm foundations for the healthy expansion of industry which will follow naturally upon rising productivity and rising real incomes. Moreover, while all the measures which are being taken to promote economic progress in these countries are essential, the only permanent solution to the problem of poverty in the Far East, as in the West Indies and southern Europe, which he can see is a drastic limitation of births.

Prof. Benham does not disguise the formidable character of the task of persuading hundreds of millions of peasants, many of them illiterate and superstitious, to change their present habits; but the task cannot be evaded or ignored. This is a task

* The Colombo Plan and Other Essays. By Prof. Frederic Benham. Pp. viii+90. (London and New York: Royal Institute of International Affairs, 1956.) 7s. 6d. net.

of communication or education, and it was virtually ignored in the debate on Commonwealth Development in the House of Commons on November 30, although that debate elicited several suggestions for more development, as well as for the conversion of the Colonial Development Corporation into a Commonwealth Development Corporation. The information or education aspect received no further mention than Mr. B. Braine's plea that existing Commonwealth machinery for collecting and disseminating economic information should be improved.

The task, in fact, as Dr. Vannevar Bush implied, is not simply one for governments, but particularly for the scientists, as citizens, though it demands a great deal of careful thought as to the ways and means by which that task should be undertaken. It is no less clear that an essential condition to-day is to create the political conditions in which such propaganda and educational work can be carried out with some prospect of success. That possibly is the main force of Mr. Gunnar Myrdal's argument in his recent book*, that the economic and technical aid given by the more advanced to the under-developed countries should be channelled through the United Nations and other international agencies such as the World Bank.

Mr. Myrdal states the case against unilateral aid impressively, not simply on the grounds of eliminating suspicion of political motives—whether they be justified or not—but equally in the interests of the contributing nations as tending to distribute the responsibility and make it more difficult for other countries to avoid participation and their share of the real sacrifice demanded. Mr. Myrdal is not optimistic as to the prospect of success, however, and even if a better international climate is secured in this way, he does not suggest that the prospects of peaceful economic progress in the backward countries are high. He recognizes that it is useless simply to preach internationalism and denounce nationalism, and to that extent he admits that the United Nations is no more than its constituent nations permit it to be. Confidence in the United Nations has been shaken by the evidence of the absence of common values and standards, and failure to apply them impartially, firmly and decisively. Until confidence is restored, it seems idle to press for any extension of the executive responsibilities of the United Nations for distributing aid, but rather to strengthen the educational work that is fundamental to international co-operation and world order. That is basic to the functioning of an international economy and to the preservation of world order, and there seems no alternative if world chaos and disaster are to be avoided. The attempt has to be made, and this symposium in the *Bulletin of the Atomic Scientists* shows how large a part scientists could play in their professional capacity, in creating an informed public opinion, alive to what is at stake, and prepared to support the measures and the sacrifices required, to enable mankind to reap the benefits which technology has put within our reach, if not to avert disaster.

* "An International Economy: Problems and Prospects". Pp. xii+381. (London: Routledge and Kegan Paul, Ltd., 1956.) 37*s.* 6*d.*

A NEW HUMAN ANATOMY

Textbook of Human Anatomy

By Prof. J. D. Boyd, Prof. Sir Wilfrid E. Le Gros Clark, Prof. W. J. Hamilton, Prof. J. M. Yoffey, Prof. Sir Solly Zuckerman, and the late Prof. A. B. Appleton. Edited by Prof. W. J. Hamilton. Pp. xii+1022 (796 figures). (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1956.) £5.

THE most cursory browsing of this new text-book suggests that here is something different. Looking at the book purely as a production, we doubt if a better volume on anatomy has emanated from Great Britain, or indeed from any other country.

We would commend at the outset the authors' clear definition of the scope of the subject. Here is something that needed to be said, for whenever the word 'anatomy' is mentioned, people are liable to conjure up in their minds a discipline which has advanced but little since the Middle Ages. The position is vastly different, for while the primary technique of anatomy remains the dissection of the human body with the scalpel, its apparatus now includes any technique which can be used for enlarging the boundaries of anatomical knowledge, even the Geiger counter by which the rate of turnover of calcium ions in bone is measured, and the electron microscope which is used for revealing the minute structure of the fibrils that make up a tendon. In the circumstances, it is inevitable that anatomy should overlap the subjects of biochemistry and physiology. The young scientist who contemplates entering the field of anatomy to-day will find at his disposal as varied a choice of subjects for research and as rich an array of techniques as can be offered in any other medical field.

We welcome, therefore, this most readable and attractive text-book, which, unlike its contemporaries, is not a mere reference book. Its great feature is that it presents an entirely new approach to an ever-expanding subject. To take but one example—in the section on the central nervous system, the student starts with the study of the basic anatomical unit, the anatomy of the neurone, and then proceeds to the anatomy of the nerve impulse followed by that of the synapse and the reflex arc. He is then introduced to the embryology of the central nervous system, from which he builds up a general plan of the brain with the formation of its four main sub-divisions. It is not until this stage is reached, when he has had a good grounding in the fundamentals, that he begins his study of the nervous system in detail.

In a book full of good features we pick out for special commendation the section on growth. This is a welcome innovation, for the subject has not been dealt with in a text-book of this kind previously. Here the student is introduced to such topics as the influence of nutrition and environment on growth, to the factors controlling the rate of growth and to the normal standards of growth in children and adults. This is dynamic anatomy which opens up a rich field of research.

Throughout the book the subject of topographical anatomy has been covered adequately. The pruning of anatomical minutiæ, which is a feature of the book, is welcomed.

Each section of the book is self-contained and is written by an author who has established a reputation

in his particular field. In the locomotor system we were pleased to see that bones, joints and muscles were considered as one unit. The important ancillary subjects of histology, embryology, surface anatomy and radiological anatomy have received adequate treatment throughout and yet are not obtrusive. What is even more important is that they have been so arranged that the student is able to build around them his knowledge of structure and function.

It appears to have been the deliberate policy of the authors to omit all references to the literature, which is perhaps disappointing. It should be borne in mind, however, that the book was written primarily for the medical student, who will need to get a firm grasp of the fundamentals of the subject before permitting himself to read more widely. Of course, there are sins of omission and commission, as is inevitable in the first edition of a book of this magnitude; but they are minor faults and can be corrected without difficulty.

We would not wish to close this review without congratulating the publishers. They have taken the long view, which in these difficult days requires courage, and have spared no expense in producing a book of which they must be justly proud. The skill of A. K. Maxwell, the greatest medical artist of his day, augmented by that of the less-experienced but equally gifted Frank Price, has been given full scope, and the many beautiful illustrations are a work of art and a joy to behold.

We feel that "Hamilton's Anatomy", or whatever it may come to be called, will be welcomed by teachers and students alike. It has undoubtedly broken with tradition and will fill a definite need. We predict that it is in for a long innings.

C. F. V. Smout

MATHEMATICS OF PHYSICS AND CHEMISTRY

Physical Mathematics

By Chester H. Page. Pp. x+329. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 42*s*. net.

Special Functions of Mathematical Physics and Chemistry

By Prof. Ian N. Sneddon. (University Mathematical Texts.) Pp. viii+164. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 10*s*. 6*d*. net.

BOTH these books are concerned with mathematical physics; but they are about as different from each other as any two books could be in their approach to the subject.

Dr. Page is chiefly concerned to understand how what we call a theorem in applied mathematics is nearly always closely associated with some physical phenomenon. It is as if he is almost thinking physically, and certainly his choice of title 'Physical Mathematics' is a far more appropriate one than the more conventional 'Mathematical Physics'. But Prof. Sneddon writes almost as if he were a pure mathematician. Those very functions, such as Hermite's and Legendre's, which arise spontaneously for Dr. Page as he wonders what would happen to a physical wave equation if it were expressed in particular types of co-ordinate, are described by Prof. Sneddon merely as the solutions of a differential equation about the origin of which no one need greatly concern themselves.

Both books are well written, and are suitable for about the same level of mathematical attainment—final-year honours or first-year postgraduate in a normal British university. But on account of the difference in approach, Page's book is more easy to read, and many of his subtler points, such as the use of the Dirac delta function in Poisson's equation, appear almost physically inevitable (as perhaps they are). Sneddon's pages are more filled with equations, with asymptotic forms and conditions for convergence, with recurrence relations and generating functions.

There is just the same difference in the central themes which unify each separate book. Page speaks of variational methods and integral equations, Gauss's theorem and eigenvalues: he has an excellent discussion of Green's functions. On the other hand, Sneddon speaks of the various confluences in the hypergeometric equation from which almost all the particular differential equations (Legendre, Bessel, Hermite and Laguerre) are derived. Yet both books have something important to say, and they say it well. It is hard to avoid the conclusion that the inevitable limitations of space in the 'little blue' Mathematical Texts have made Sneddon's book a bit more congested than he, or his readers, would have desired. Some parts of it do have the appearance of a compendium of useful results. Dr. Page, on the other hand, with more space at his disposal, can afford to be almost chatty: "You will recall . . ." is how he begins one paragraph.

As a result of these differences there is almost no direct overlapping in the contents. The only one of Sneddon's chapter headings which even appears in the index of Page's book is the last and shortest, on the delta function.

It is seldom entirely fair to describe books of this kind, which cover a wide range, in a single phrase. But if I were pressed to do so, I should say that Page was concerned to see the structure of mathematical physics—in a word, to understand it: and Sneddon wanted to have a good collection of tools, which would be very useful when there was a job to do, even though they had their existence quite independently of this particular job.

Such is the difference between these two books. Whether it arises from the fact that Dr. Page is consultant to the Director of the U.S. National Bureau of Standards, and Dr. Sneddon is professor in a university mathematics department, I do not know. But I do know that anyone reading both books would be well equipped both to understand and to handle the mathematics of theoretical physics.

C. A. Coulson

ANTIBIOTICS

Antibiotics Annual, 1955–1956

Edited by Dr. Henry Welch and Dr. Felix Marti-Ibañez. Pp. xviii+994. (New York: Medical Encyclopedia, Inc.; London: Interscience Publishers, Ltd., 1956.) 10 dollars.

THE American Antibiotics Symposium seems now to have become firmly established as an annual event. The papers read at the Symposium are collected in the "Antibiotics Annual", the third volume of which presents the contributions to the meeting held at Washington, D.C., in November 1955. This volume affords a useful indication of the recent trend of research in antibiotics.

In the notice of the second volume (*Nature*, 177, 496; 1956) it was stated that the subject of antibiotics seems still to be in the exponential stage of development. The development now appears to have reached a plateau, since the third volume of the Annual contains only 150 papers and less than 1,000 pages as compared with the 172 papers and 1,150 pages of volume two. This trend is reflected in the production of antibiotics in the United States since, according to the opening remarks of Dr. Henry Welch, there is an apparent decrease of about 8 per cent in the first half of 1955 as compared with 1954, for which full year the production was 855,000 kgm. The decline, however, is related to a decline in exports, due to the increasing production of foreign antibiotic plants.

Inevitably, owing to the cost of travel, a large proportion of the contributors to this third symposium are still of United States origin, but the number of foreign contributors has now increased to some 12 per cent of the total; they are derived from 15 different countries. This may indicate a widening interest in research in the antibiotics field—an interest which is emphasized by the holding of the first European antibiotics symposium at Milan in 1956.

Much work is still directed to the study of the pharmacological and clinical use of antibiotics, alone or in conjunction with other antibiotics, synthetic antibacterial agents or with vitamins. In addition to the examination and further evaluation of the 17 antibiotics now in commercial production, more than thirty papers are devoted to new antibiotics, some of which may eventually be found to have useful clinical applications.

The results obtained with cycloserine are described as an antibiotic paradox. This particular antibiotic, although fairly active *in vitro*, was found to be inactive in mouse and guinea pig tuberculosis and other infections in animals. It would normally have been rejected, but owing to its virtual lack of toxicity in animals it was tried clinically and found to be highly effective in man. This raises the question as to whether the *in vivo* results in animals are any more reliable than the somewhat discredited *in vitro* technique for the assessment of the value of a new antibiotic.

A new feature of the 1955 symposium is the institution of panel discussions, three of which are reported. In these, panels of selected experts consider some of the vexed topics in the field in which considerable divergence of views is possible. These discussions form a very useful supplement to the present volume.

J. H. Birkinshaw

STEEL MAKING WITHOUT NITROGEN

Oxygen in Iron and Steel Making

By J. A. Charles, W. J. B. Chater and J. L. Harrison. Pp. xii+309. (London: Butterworths Scientific Publications, 1956.) 42*s*.

THE objects of using oxygen in iron and steel making are to save fuel and to increase output, both of which objectives are becoming increasingly important as the world demand for steel rises and the more accessible sources of fuel become exhausted. It is very useful to have a comprehensive survey of the rapidly growing literature on this subject which the authors have contrived to keep free from bias so that the student or the works manager can find out how to calculate the probable gains from the use of oxygen and see whether it will be economic. Oxygen is used at least experimentally for the three main purposes of (i) blowing or lancing molten metal to oxidize mainly carbon and silicon, (ii) for blast enrichment (namely, reducing the inert nitrogen content of the blast) in solid-fuel burning shaft furnaces (blast furnace, cupola and gas producer), and (iii) in reducing the nitrogen in the combustion air for open hearth flames. The book accordingly deals with these three purposes in three separate sections each of which starts with a theoretical study that is very useful but tends to overlap the more practical treatment in the succeeding chapters. The order of these three sections is wisely chosen, as in the reviewer's opinion it corresponds exactly to the order of potential value of the three processes. There is no doubt that oxygen lancing in the open hearth and arc furnaces and the use of oxygen in convertors or ladles have come to stay, although they do involve fume problems to which a chapter is devoted but which cannot cheaply be solved. The authors very fairly conclude that in the blast furnace, oxygen is not a good alternative to high blast preheat unless one is concerned with special high-temperature endothermic reactions as in the manufacture of ferromanganese or one has no hard coke or ore and cannot operate a high-shaft process.

In the use of oxygen for the flame of the open hearth furnace there are theoretical advantages in reducing the nitrogen of the whole of the combustion air and detailed calculations of these are reported. However, in practice the open hearth furnace uses considerably more air than the stoichiometric quantity and much of this leaks in through walls without passing through the preheater. There is thus not much relation to the ideal system, and much cheaper gains can be obtained by good air control than by adding oxygen to the combustion air. This is why in the reviewer's opinion this application of oxygen is rightly given third priority. The most valuable results have been obtained when combustion oxygen is used as a medicine for sick or inadequate furnaces rather than to change the overall thermodynamics. Oxygen in particular can be used as a jet introduced close to the fuel jet to accelerate mixing and to raise the temperature of the first few feet of the flame. All these possibilities are fully discussed mainly as a collection of abstracts from the published papers; these naturally vary in the amount of information given on which the general applicability of the results can be assessed.

In the second section some results on the use of oxygen in gas producers are also given and these results are of wider interest than the title of the book indicates, since they are more concerned with the manufacture of towns gas from non-coking coals for uses other than the firing of furnaces in the iron and steel industry. Nevertheless, it is useful to include them so as to make the book a compendium on the general use of oxygen for combustion, and in that connexion the use of neat oxygen for the firing of very small furnaces operating at 2,000° C. might also have been mentioned as it has interesting potential applications for other very high-temperature processes.

The book can be recommended as a valuable essay in bringing together and making accessible the present state of knowledge on the subject, although I would prefer a more critical summary of the experimental results at the end of each section.

M. W. Thring

Introductory Quantitative Chemistry

By Axel R. Olson, Charles W. Koch and George C. Pimentel. (Series of Chemistry Texts.) Pp. x+470. (San Francisco: W. H. Freeman and Company; London: Bailey Bros. and Swinfen, Ltd., 1956.) 5 dollars; 42*s*. 6*d*.

THE authors, all on the staff of the University of California, write for first-year students, including those not 'majoring' in chemistry. They have taken great pains to further their aim of giving a philosophical, enlightened and interesting introduction to analysis, and they have succeeded in presenting it as a subject worthy of serious study.

The table of contents, which begins with weighing, measuring and other customary introductory matter, is not unnecessarily crowded with theory. Instead, the physical principles considered are wisely limited to those having a direct bearing on analysis. Thus, there are chapters dealing with such topics as the evaluation of quantitative data, reversible systems, solubility and precipitation, and the physical structure and growth of precipitates. The combined ideas, teaching experience and scholarship of the three authors have manifestly gone to the making of these chapters, which are exceptionally clear and of great teaching value. The main part of the book consists of gravimetric and volumetric procedures described and applied to familiar determinations, such as those used in Intermediate Science courses in Britain and in first-year university work. An unusual chapter on the biologically important polybasic acids, illustrated with no less than fourteen titration-curves, and ending, as do all the chapters, with a great variety of questions, gives some idea of the style of the book and of the thoroughness of the treatment.

By considering some of the simpler methods of physical analysis, the authors have brightened their book and given scope and encouragement to the abler students. Their selection includes several determinations by colorimetry, and one or more by electrolytic separation, carrier separation, and by the use of ion-exchange resins. Before any determination is undertaken, by whatever method, attention is directed to the significance of the result of a preliminary investigation, and to the necessity of framing the plan of work on the underlying theory. The difficulty of the exercises is graded to train the student to be self-dependent. This is not a reference manual of analysis: it is a bright, well-written, instructional book of the first class. G. Fowles

Advances in Applied Mechanics

Vol. 4. Edited by H. L. Dryden and Th. von Kármán. Pp. x+413. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 10 dollars.

THIS collection of seven surveys of selected topics in continuum mechanics is the latest addition to a useful series. The publication of these occasional volumes was initiated some years ago by R. von Mises, and the editorial work is now in the hands of G. Kuerti. H. L. Dryden and Th. von Kármán are the general editors, with three European scientists as associate editors.

Two of the articles in this volume are concerned with elasticity of solids (non-linear elasticity, and elastic instability), two with the physical properties of solids (fatigue, and dislocation theory of plasticity), two with fluid mechanics (turbulent boundary layers, and three-dimensional boundary layers), and one with mathematical technique (the method of co-ordinate perturbation for finding approximate solutions of differential equations). The scope of the field from which the surveys are drawn is too wide for any one reader to be interested in them all, but the subjects are well chosen and most people active in this field will be drawn to one or two of them. F. Clauser's careful and systematic account of what is known about turbulent boundary layers appealed especially to me. On the whole, the writing seems to have that extra degree of clarity and authority that is so important in accounts of the present state of research. G. K. Batchelor

Thermodynamic Tables and Other Data

Edited by R. W. Haywood. Pp. 23. (Cambridge: At the University Press, 1956.) 2*s*. 6*d*. net.

THIS little book of tables is a first-class production. The data in it have been collected from various sources and are presented clearly in a way which will commend itself, particularly for use by students. Further, the price is a modest one.

The list of contents falls into three parts. The first of these contains a selection of general information on gases, such as calorific values, molecular weights, etc. The second part is devoted to steam tables and contains triple-point data; properties of saturated water and steam; super-heated steam; compressed liquid water. The last part concerns refrigerants and contains properties of ammonia, carbon dioxide, 'Freon-12' and methyl chloride.

R. E. D. Bishop

Come Rain, Come Shine

More Country Contentments. By John Moore. Pp. 256. (London: William Collins, Sons and Co., Ltd., 1956.) 18*s*. net.

THE smell of bonfires, the cawing of rooks, all the scents, sounds and sights of the countryside, particularly the Cotswold country, come to us from the pages of John Moore's latest book, "Come Rain, Come Shine". In it he wanders at large through garden, orchard, field and coppice. He also strolls down the village to watch the fair or seek a drink at the 'pub'. He tells us of country personalities, human and otherwise, from his special pal the kind-hearted, red-faced Colonel, down to insects, such as the members of his colony of large blues among the wild thyme. He writes of this rare and lovely butterfly with special enthusiasm. Its rarity, he points out, is due to a peculiarity of its life-history. "After its third moult the caterpillar wanders away from its food plant and allows itself to be discovered by a particular kind of ant, which seizes it", not to devour it but to carry it off to the nest, where it is carefully tended, "for it exudes from a gland in its body a kind of sweet liquid which is to the ant as honeydew or indeed ambrosia".

Fed on young ants, the caterpillar is kept the winter through, hibernating until spring, when it is again fattened up on ant grubs, until it changes into a pupa. "Out of this chrysalis in July there emerges what I think is one of the loveliest of our British butterflies and having found its way by a complexity of corridors out of the anthill and into the sunshine, it takes wing and flies in the sun". The reader will find many similar descriptions of things big and things little in Mr. Moore's most charming country pages—they are full of country scenes and country people. Frances Pitt

A CRYSTALLIZABLE INSECT VIRUS

By Prof. ROBLEY C. WILLIAMS and Dr. KENNETH M. SMITH, C.B.E., F.R.S.
Agricultural Research Council Virus Research Unit, University of Cambridge

An interesting virus affecting the larvæ of *Tipula paludosa*, the crane fly, was first discovered by the Agricultural Research Council Virus Research Unit at Cambridge in 1954, and was later briefly described[1,2].

The site of virus multiplication may be inferred to be the cytoplasmic regions of the fat-body cells, for it is here that the virus is found to be most heavily concentrated. The intracellular virus appears to avoid the nucleus completely, as may be seen in Fig. 1. This behaviour is in marked contrast to that of a polyhedral virus affecting the same insect, where the virus particles are found within the nuclei of the larval blood cells. The quantity of the cytoplasmic virus produced by a larva in a late stage of the disease is astonishingly large, as has been previously intimated[2]. We have now compared the dry weights of the extracted, purified virus and of the whole, diseased larva. In the sample measured (two larvæ) the virus weighed approximately 25 per cent as much as the entire larva. This yield is easily a record for animal viruses, and is more than twice that reported for tobacco mosaic virus, where the dry weight of the purified virus may be as much as 10 per cent of that of the diseased plant leaves. Only the yield of the *T*-even bacteriophage from infected cells of *E. coli* may be of comparable magnitude.

Previous experiments[1] with Feulgen staining have shown that the *T. paludosa* cytoplasmic virus contains deoxyribonucleic acid, but its amount per virus particle has not yet been determined.

The purification of the virus particles is particularly simple, owing to their large size and to the absence of particles of comparable size in extracts of diseased larval tissue. In order to obtain a purified virus suspension, the larvæ are first cut up and placed in a beaker of water for several hours. After clarification of the resulting extract by low-speed centrifugation, the virus is obtained essentially pure by the application of two cycles of high- and low-speed centrifugation. Distilled water appears to be a suitable suspending medium.

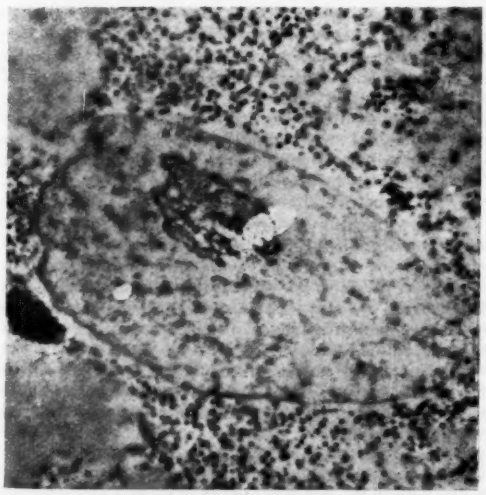

Fig. 1. A section cut through a fat-body cell of *Tipula paludosa* infected with a cytoplasmic virus. It is seen that the nucleus is devoid of virus particles, whereas the surrounding cytoplasm contains them abundantly. × 8,000

The pellets of virus resulting from centrifugation have fascinating optical properties, briefly referred to previously[1]. By transmitted light the pellet appears an orange or amber colour. By reflected light it has an iridescent, turquoise appearance. Within the pellet may be seen small regions reflecting the incident light quite brilliantly, giving the entire pellet the appearance of an opal. The cause of this optical phenomenon will be discussed below. The pellet may be best prepared for embedding (preparatory to sectioning for electron microscopy) by taking care not to disturb the mass of the pellet during fixation with osmic acid and during dehydration with alcohol. At the start of each of these procedures, the centrifuge tube containing the pellet is re-inserted into the centrifuge in its initial orientation. If care is taken in this regard, the methacrylate-embedded pellet has much the same appearance as does the original one, except that the small regions of intense reflexion are now more sharply defined and the reflected colour is violet or indigo.

When the embedded pellet, so prepared, is sectioned and examined in the electron microscope, the general appearance is that shown in Fig. 2. The pellet is seen to consist of regions of crystallinity, the average diameter of which is 5–10μ. Since the crystals are randomly oriented with respect to each other, a given section will cut them in different directions with respect to their faces, and the bizarre pattern shown in Fig. 2 will result. The centre-to-centre distance of the virus particles in the closest packed arrays yet found is 1300 A. The origin of the reflexion effects in the initial pellets, and in the embedded ones, is now evident. Bragg reflexions result from the periodic particle arrays, and the scale of size of the inter-particle spacing is such as to make visible the effects of the Bragg reflexions. Exact calculation of the anticipated wave-length of the constructively interfered light is impossible, since the index of refraction of the fixed, dehydrated, and methacrylate-embedded virus particles is not known. The change of the reflected colour from turquoise to violet upon fixation and dehydration of the pellet is due to shrinkage of the inter-particle spacings. The inverse effect can be demonstrated upon re-hydrating an unfixed, but partially dried, pellet. At first the pellet is neutral by reflected light; but as it swells upon rehydration, the first colour to appear is violet, followed by indigo, blue and finally turquoise.

The appearance of the sections of the virus pellets is similar to that shown[4] for the nuclear inclusions of an APC virus growing in HeLa cells. In this case the virus particles have been reported to be packed into a lattice believed to be body-centred cubic[5]. We

Fig. 2. A section through a methacrylate-embedded pellet of purified *T. paludosa* virus. This low-magnification micrograph shows the patterns resulting from a transection made through small crystalline regions oriented at random. × 8,000

have not yet been able to establish with certainty the type of crystal packing in our virus pellets, but the occurrence of square arrays and hexagonal arrays, with identical inter-particle spacing, leads us to suggest that the packing is face-centred cubic.

It can be seen from the electron micrograph at higher magnification (Fig. 3) that the virus particles nowhere appear to touch. We believe this effect is due to the presence of an outer, low-density envelope around the more dense virus centre. This dual structure can be seen in unshadowed electron micrographs of air-dried virus particles, and also in sections of embedded fat-body tissue, where the particles are not so tightly packed. We would conclude that the virus particles are actually touching in these close-packed arrays, but that the outer envelope is either so tenuous, or so poorly staining, that it is not seen.

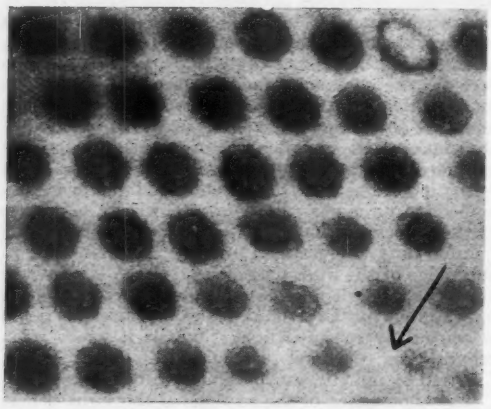

Fig. 3. A high-magnification micrograph of a section through a virus pellet, showing a portion of an array in which the virus particles are arranged approximately in a hexagonal pattern. Several of the sectioned particles appear to have a six-sided contour. The direction of motion of the microtome knife is shown by the arrow. × 70,000

We have made some attempts to grow crystals of the virus in water suspensions by the addition of half-saturated ammonium sulphate, and by simple evaporation. Our success so far is limited to the size and type of crystal shown in Fig. 4, using the latter method.

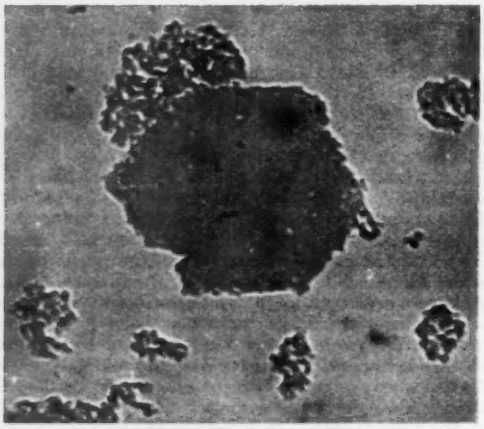

Fig. 4. A light-micrograph of a crystal of *T. paludosa* virus, formed by partial evaporation of a water-suspension of the virus. Bits of poorly-formed aggregates are seen in the vicinity of the hexagonal plate. × 2,000

Some notion of the shape of the individual virus particles can be obtained from micrographs of the sections. It is evident (Fig. 3) that the bodies seen are not spherical, but must be polyhedral. A six-sided figure is frequently seen; generally not a regular hexagon, but with two opposite sides slightly longer than the other four. This may be an effect of distortion during microtomy. In the hexagonal arrays the orientation of the straight edges of each particle is usually such as to present these edges to the nearest neighbours. Six-sided virus contours are also invariably seen in the square arrays, but the orientation habit is not yet evident. Extensive examination of serial sections may provide us with a knowledge of the shape of the virus particles as well as the type of crystal packing. Since the particles also appear six-sided when dried from a water suspension, their true polyhedral shape should be discernible from an application of shadowing methods and of stereoscopy. This appears to be the first animal virus reported to have a polyhedral shape.

The cytoplasmic virus of *T. paludosa* appears to have a combination of characteristics that renders it attractive for further physical and chemical study. (1) It can readily be produced in large quantities (5–10 mgm. per larva), and can be purified with ease by simple centrifugation; (2) it appears to contain deoxyribonucleic acid; (3) it is the largest virus yet found to possess an apparently complete uniformity of size and shape; (4) the individual virus particles are polyhedral in shape, suggesting a highly ordered internal structure.

[1] Xeros, N., *Nature*, **174**, 562 (1954).
[2] Smith, Kenneth M., *Nature*, **175**, 12 (1955).
[3] Smith, Kenneth M., *Proc. Roy. Inst.*, **35**, 832 (1954).
[4] Morgan, C., Howe, C., Rose, H. M., and Moore, D. H., *J. Biophys. Biochem. Cytol.*, **2**, 351 (1956).
[5] Low, B. W., and Pinnock, P. R., *J. Biophys. Biochem. Cytol.*, **2**, 483 (1956).

BOMBARDMENT OF THE EARTH BY METEORS

A GEOPHYSICAL Discussion on "The Bombardment of the Earth by Meteors and Meteorites" was held at the Royal Astronomical Society on November 16. The chair was taken by Prof. A. C. B. Lovell, and the discussion was opened by Dr. M. H. Hey, of the British Museum, who dealt with meteorites.

Dr. Hey said that the direct contribution of the larger meteorites to the Earth is almost certainly negligible compared with that of meteors and micrometeorites. Estimates range from 1 to 50 tons *per diem*, and the lower end of this range seems the most probable. It is quite possible that in the earliest phases of the Earth's history the position may have been quite different, but because nickel is a geologically mobile element, readily transported by ground waters, we cannot hope to recognize the remains of meteorites in ancient sediments, however numerous they may have been.

The craters made by the larger meteorites are conspicuous to-day, but geologically speaking they are evanescent features, quickly obliterated by erosion, and though R. S. Dietz claims to have discovered two 'fossil' meteoritic craters of Palæozoic date, his evidence has not been considered adequate by geologists in general. The suggestion has been made by J. Kaljuree, H. P. T. Rohleder, J. Boon and C. C. Albritton, and others, that gigantic meteorites may have been responsible for such geographical features as the Carpathians and Hungarian Plain, the Nordlinger Ries, the Pretoria saltpan and the Vredefoort ring-dyke, but the evidence that ordinary well-known geological agents were not responsible for these structures is quite inadequate, and geologists hesitate to invoke a new agent where the known ones are competent.

It is certainly possible that major meteorites, much larger than anything we know of to-day, may have fallen in early times, may even still be falling at wide intervals, and may be responsible for geographical features still extant, but there is no proof of anything bigger than the two-mile Ungava crater (and that is doubted by some).

Although the meteorites may be geologically unimportant, they have a major interest as the only samples of extra-terrestrial matter that we can handle and study in the laboratory in any detail. Unfortunately, their chemical analysis is particularly difficult, and a very large proportion of the analyses in the literature are quite unreliable; and more unfortunate still, the very elements in which we are most interested are those for which the available figures are worst. Almost all the analyses we have are bulk analyses; little is known of the distribution of the elements among the metallic, sulphide, phosphide and several silicate phases present; what little is known is highly interesting, and suggests that when we have the necessary data we may be able to assess the pressure and temperature conditions under which meteorites were formed—and the relevance of this to cosmology and geophysics is obvious. Work is now on hand at the British Museum, in collaboration with Harwell and Oxford, on this problem, but it must be some years before we have the required data.

There are, however, many interesting points about the chemistry of meteorites, some of which have been known for many years. Some 90 per cent of all meteorites are essentially stony, nearly 10 per cent are a nickel–iron alloy, and a very few are roughly half-and-half metal and silicates. The irons, which contain anything from 4 to 40 per cent nickel, are normally either single crystals of the nickel-poor phase, or single crystals of the nickel-rich phase (which is stable throughout the system at high temperatures), from which lamellæ of the nickel-poor phase have segregated in regular orientations. There are also regular segregations of nickel–iron phosphides or carbide, and when we know more of the composition of these segregates, and the distribution of the minor elements present between them and the two metallic phases, we may know more of the conditions under which these enormous single crystals grew and segregated.

The majority of the stony meteorites are quite unlike any rocks of the Earth's crust. Not only are they veined with nickel–iron alloy, but also they have a remarkably high magnesium and low aluminium and alkali content. In these last respects a few terrestrial rocks of deep-seated origin approach the meteorites, but structurally they have no terrestrial analogue; for the typical meteorite is made up of small rounded silicate grains—chondrules—embedded in a matrix of broken chondrules, small crystals, glass and veinlets of metal. Only a tiny fraction of stony meteorites —about 10 per cent—lack this particular structure, and about half of this small group is peculiar in being almost free from metal, having far more calcium, alkalis and aluminium than the typical meteorites, and having a structure approximating more nearly to rocks of the Earth's crust.

Besides these main classes of meteorites, any theory that assigns a single origin to all meteorites has some curious rarities to explain as well. First, there are the carbonaceous chondrites, a small group in which a silicate matrix with the composition and structure of a typical stony meteorite, a chondrite (if the rather poor analyses so far available can be relied on), is impregnated with hydrocarbons. The silicates bear every sign of an igneous origin, but the impregnating hydrocarbons begin to decompose at about 100° C.

Then there are the tektites, which can only be regarded as glass meteorites. These bodies are found in about half a dozen regions of the Earth, and probably arrived in as many separate showers at epochs ranging from mid-Tertiary to Recent. No tektite has ever been seen to fall. It is clear that falls are very rare events, though when a fall does occur the number of individual masses is very great. Chemically, the tektites differ from all stony meteorites and from all terrestrial rocks; they are very high in silica, and relatively high in alumina and potash. They appear to enter the atmosphere as roughly spherical masses, wholly glassy (apart from small residues of quartz), and probably up to about 500 gm. in weight. Their origin and their relation to the common stony meteorites are still quite obscure. The large irregular masses (up to about 2,000 gm.) of almost pure silica glass (98 per cent SiO_2) found

in the Libyan Desert are possibly related in some way to the tektites; certainly no convincing explanation assigning a terrestrial origin to them has yet been offered.

Finally, Dr. Hey commented on the impact of a really big meteorite with the Earth. He said that a meteorite reaches the Earth with its cosmic velocity nearly unchecked, and the whole of its kinetic energy must be dissipated within a few seconds; some passes into sound and earthquake waves, but most is converted into heat. Considerable quantities of the meteorite itself and of the surface rocks are fused and even vaporized, and most of the meteorite is back-fired in fragments out of the crater produced. The great Siberian meteorite of June 1908 unfortunately fell in a boggy area, and no material has been recovered, but the Sikhote-Alin fall of 1947 has confirmed many of the conclusions drawn from the Arizona, Wabar and Henbury craters; but there is still a lot to be learnt about the mechanics of crater formation.

Prof. H. Bondi then read a paper by Mr. T. Gold, who was unable to be present. In this paper Mr. Gold took a view opposed to that of Dr. Hey about the geological importance of meteorites. In Mr. Gold's view the Earth was formed by accretion due to meteoric impact and that at the present time we are merely experiencing the tail-end of this bombardment and accretion process. Such a theory of the origin would naturally suggest comparison with the Moon. There the surface appears to have been shaped by powerful explosion impacts, some of such magnitude that it is not a great step to suggest that the entire Moon may have been formed by the accumulation of pieces. Clearly, if the Moon itself had grown in that way, then pieces of a size capable of making very large craters could have grown. It is therefore consistent that the Moon, after sweeping up all bodies accessible to it, should show markings of very major collisions, although most probably the bulk of the material was accreted as fine dust. The corresponding features on the Earth will have been subjected to the incomparably more rapid terrestrial erosion, and also to the terrestrial processes of continental growth, of mountain building, and all the upheavals of internal origin which have been absent on the Moon.

At the present time, attempts are made to measure the quantity of fine dust settling down through the atmosphere, by the use of trays exposed in polar regions, but such measurements are made difficult by the substantial admixture of dust of terrestrial origin. Estimates are also made of the quantity of material contained in detectable meteors hitting the Earth. But there the largest mass is certainly contained in the smallest particles, and this strongly suggests that if still smaller particles could be measured the mass contained in those would be much greater still. The attempt to extrapolate into the unknown size region, from a knowledge of the number–size relation that is observed among the larger meteors, is not really sound, as there is reason to suppose that the smaller particles will be subject to different forces and will therefore be channelled into different orbits in the solar system.

Perhaps the best hope of measuring the quantities involved is to detect the admixture of certain substances in ocean deposits. Nickel has been used by Pettersson and Rotschi, as it is a material common in meteoric matter but rather rare in the particular materials that have come to form the continental and crustal rocks. In red clay ocean deposits they found amounts of nickel which, if interpreted as meteoric, would indicate a rate of the order of one million tons per year for the whole Earth. They found an effect which is consistent, namely, that those clays which are independently estimated as having been deposited more slowly contain the highest proportion of nickel. They also found indications that the rate in the past may have been variable. Estimates based on the zodiacal light would also indicate a similar rate of deposition and one can therefore have some confidence that this figure is not completely in error. Can this have been the rate throughout geological time? The quantity would amount to a deposit of about four-metres thickness since Palæozoic times. Of course, no such collected deposit can be found anywhere because of the other processes that occur on the surface of the Earth.

As there is little doubt that the bulk of the mass at the present time is entering in the form of very small pieces, much smaller than visible or radio meteors, one has to look to high-altitude rockets or satellite techniques for an eventual measurement of the quantity involved. The large end of the size spectrum is also of interest, even if it has not contributed a dominant amount to the total mass. The meteorites are pieces which have evidently been compacted and metamorphosed elsewhere and which show that the separation of iron from silicates has taken place elsewhere, as it appears to have done on the Earth.

The very large impacts have left clear markings on the Moon, and so one wonders whether any are to be expected on the Earth. About five craters of a mile or more in diameter are believed to be meteoritic, and of these the Arizona Crater and Chubb Crater (Ungava) are the clearest examples. Both these are very young, probably only about ten thousand years or so old, and the other examples are probably not a great deal older. It is clear that craters of such a type would not survive for long on the Earth, as they would be eroded in a few thousand years. From the known examples it can be estimated that craters between one and two miles in diameter occur now at the rate of one per five thousand years. Since Palæozoic times this would amount to some hundred thousand such craters. No geological evidence for or against such an amount has been found; on the Moon, however, a corresponding number of such craters exists, and there they are just the smallest that can be recognized from the Earth. One can infer, from the overlap of craters there, that the great majority of these small craters are younger than most of the large craters, and that the bombardment by the smaller pieces therefore continued after the really heavy bombardment was over. The lunar comparison is really even more significant, for the number of terrestrial craters that must be inferred from the few known ones is in any event quite a substantial number. Even if the present time was taken as a statistically anomalously rich period, one could scarcely estimate less than ten thousand in 10^9 years.

Where are the favourable places to look for all the old craters of the Earth? In the deep ocean they would be preserved, but the presence of the ocean itself would have protected the ground from impacts that might have left craters of the order of a mile in diameter. Deep ocean regions do not appear ever to have been on the surface, and in shallow oceans the rate of sedimentation is usually very high, so that

Table 1

Magnitude	No. km.$^{-2}$ hr.$^{-1}$ brighter than magnitude: Sporadic	Perseid	Geminid	Arietid	Kgm. day^{-1} mag.$^{-1}$: Sporadic	Perseid	Geminid	Arietid
0	1×10^{-3}	$3{\cdot}5 \times 10^{-4}$	5×10^{-4}	4×10^{-4}	13	55	3	1·8
1	$2{\cdot}5 \times 10^{-4}$	$5{\cdot}5 \times 10^{-4}$	$3{\cdot}3 \times 10^{-4}$	$1{\cdot}6 \times 10^{-4}$	13	35	7·5	2·9
2	$6{\cdot}3 \times 10^{-4}$	$8{\cdot}8 \times 10^{-4}$	2×10^{-4}	$6{\cdot}3 \times 10^{-5}$	13	22	19	4·5
3	$1{\cdot}6 \times 10^{-4}$	$1{\cdot}4 \times 10^{-3}$	$1{\cdot}3 \times 10^{-3}$	$2{\cdot}5 \times 10^{-4}$	13	14	21	7·2
4	4×10^{-4}	$2{\cdot}2 \times 10^{-3}$	$2{\cdot}3 \times 10^{-3}$	1×10^{-3}	13	9	14·6	11·4
5	1×10^{-3}	$3{\cdot}5 \times 10^{-3}$	4×10^{-3}	4×10^{-3}	13	5·5	10	18
6	$2{\cdot}5 \times 10^{-3}$	$5{\cdot}5 \times 10^{-3}$	$7{\cdot}3 \times 10^{-3}$	$1{\cdot}6 \times 10^{-2}$	13	3·5	6·9	29
7	$6{\cdot}3 \times 10^{-3}$	$8{\cdot}8 \times 10^{-3}$	$1{\cdot}3 \times 10^{-2}$	$6{\cdot}3 \times 10^{-2}$	13	2·2	4·7	45
8	$1{\cdot}6 \times 10^{-2}$	$1{\cdot}4 \times 10^{-2}$	$2{\cdot}3 \times 10^{-2}$	$2{\cdot}5 \times 10^{-1}$	13	1·4	3·2	72
9	4×10^{-2}	$2{\cdot}2 \times 10^{-2}$	$4{\cdot}1 \times 10^{-2}$	1	13	0·9	2·2	114
10	1×10^{-1}	$3{\cdot}5 \times 10^{-2}$	$7{\cdot}1 \times 10^{-2}$	4	13	0·5	1·5	180
Total (kgm.)					143	150	94	480
Mass brighter than mag. 0 (kgm.)					140	2,000	—	—

craters would fill up quickly with sediments in most cases. On the continents, the rate of erosion and sedimentation is too high; and it appears that there are no large regions where the present surface has been within two hundred feet of the surface for long periods of time, and this would be required if craters of the order of one or two miles diameter were to be recorded there. It would, of course, be most interesting to look for such craters in regions that may have been particularly favourable, such as where a hard rock was exposed for a period and later preserved by a cover of sediments. On the Moon there are, however, great numbers of craters larger than one or two miles in diameter. These must have mostly occurred earlier in the sequence of events; but, on the other hand, since they are so very large, one may wonder whether any recognizable effects can still be found on the Earth. The geological record starts when the construction of the Earth was substantially complete. There has probably been an extrusion of the lighter continental rocks from the interior, and this has made up the present surface. The crater structure that might have been there before would be completely obscured by this process.

There is, however, a speculation with regard to these early craters which it may be worth pursuing. They may well have left a pattern of gravity anomalies or unbalance of the crust, due to the destruction of the hydrostatic stratification that may have already been present. This disturbance pattern below the crust may have been the biggest irregularity then and it may have influenced all the subsequent irregular occurrences. It may be still that pattern which now gives rise to zones of instability, gravity anomaly, regions of earthquakes and volcanoes and, possibly, the sites of continental growth; this may be the interpretation of the clear and remarkable tendency for patterns of circular arcs in all these phenomena that reflect the sub-crustal properties. Such circular arcs cover a wide range of size quite similar to the circular arcs still seen as the oldest recognizable markings on the Moon. In conclusion, Prof. Bondi said that the investigation of the meteoric and meteoritic bombardments that the Earth has received and the interpretation of the lunar features may be one of the ways in which new evidence can be obtained to tackle the problems of the origin of the solar system and the internal constitution of the Earth.

The third main contributor was Dr. J. G. Davies, of the Jodrell Bank Experimental Station, who spoke on the subject of meteors. He said that the numbers of meteors of different magnitudes bombarding the earth can be deduced from visual, photographic or radio observations. The figures used here are based on radio work, since only this method yields systematic observations for twenty-four hours a day. Visual results do not differ significantly from these. The magnitudes quoted are based on the electron line density in the trail, a meteor of magnitude + 5 giving 10^{12} electrons per cm. The mass is assumed to be proportional to the electron line densities, a meteor of magnitude + 5 having a mass of the order of 10^{-3} gm.

Defining the mass distribution

$$\varphi(\alpha)\, d\alpha = c\alpha^{-s}\, d\alpha$$

as the flux of meteors passing through the unit area of a plane perpendicular to the direction of motion with line densities between α and $\alpha + d\alpha$, the flux of meteors with line densities greater than α is then

$$\theta(\alpha) = \frac{c}{(s-1)\,\alpha^{s-1}}$$

The constant s determines the proportion of bright and faint meteors in the shower. If $s = 2$, the total mass in each magnitude group is constant; larger values of s indicate a preponderance of mass among the smaller particles, and smaller values of s represent mainly bright meteors.

In Table 1 sporadic meteors are compared with three showers, the Perseids, Geminids and Arietids. The value of s for sporadic meteors is found to be close to 2·0, for Perseids 1·46, for Arietids 2·5, and for Geminids brighter than magnitude + 3, 1·62, while for fainter Geminids $s = 3{\cdot}0$. The first column gives the meteor magnitude, and the next four columns give the flux $\theta(\alpha)$ per sq. km. per hour of meteors brighter than the given magnitude. The final four columns give the mass per unit magnitude falling on the whole Earth per day. The total mass for the magnitude-range 0 to + 10 is given with an estimate of the mass in brighter meteors. It is clear that a cut-off must exist, since no meteorite is known to have belonged to any shower. It is more difficult to estimate the mass in smaller particles. Measurements of the zodiacal light indicate that the numbers must rise considerably above those given by extrapolation of the known mass distribution.

Dr. E. J. Öpik has shown that the Poynting–Robertson effect would have caused all particles less than 6 cm. in radius which were originally less than 5 astronomical units from the sun to fall into the sun in less than about 4×10^9 years. Particles of sizes between 6 cm. and 0·03 cm. would move through the region of Jupiter's orbit so slowly as to have a very small chance of avoiding collision with Jupiter. Smaller particles would, however, spend less time in the region of Jupiter,

and hence would not be swept up by the planet. This limit occurs near magnitude + 9, and an increase in numbers fainter than this may therefore arise. A recent radio echo survey of meteor orbits in the magnitude range + 7 to + 8 shows a new class of orbit of small eccentricity and high inclination, unknown in brighter meteors. These may be meteors of great age that have escaped the sweeping action of Jupiter, and their numbers may well increase rapidly with magnitude.

Many speakers from the floor took part in the ensuing discussion, during which several points of interest arose, particularly on the question of the origin of the various particles. In this connexion it was pointed out that meteors seemed to be very fragile, and hence it was unlikely that they had a common origin with the meteorites. On the other hand, the micrometeorites, which have a high nickel content, might well have a common origin with the meteorites.

UNIVERSITY COLLEGE OF SWANSEA

NEW SCIENCE LABORATORIES

By Prof. H. E. STREET

FROM its foundation in 1920 the University College of Swansea established Departments of Geology and Biology. Geological studies have in turn been directed by Profs. A. E. Trueman, T. N. George and D. Leitch. The present professor, Dr. F. H. T. Rhodes, was appointed in 1956. A lecturer in geography was first appointed in 1931 within the then newly named Department of Geology and Geography. The increasing number of students in geography led the College first to increase the geography staff within the joint department and in 1954 to create a separate department for this subject with Dr. W. G. V. Balchin as its professor.

The Department of Biology from its inception initiated an honours course in botany but only provided zoology courses to the subsidiary level. In 1936, Dr. Florence A. Mockeridge, previously independent lecturer, was appointed professor of botany and head of the Biology Department. On her retirement in 1954 the department was constituted as a Department of Botany with Dr. H. E. Street as professor. In 1956 a separate Department of Zoology was established and Dr. E. W. Knight-Jones was appointed to this new chair.

The development of teaching and research in these sciences, leading to the establishment of four separate departments, made new and more extensive accommodation essential. The College is indebted to the late Prof. Duncan Leitch and to Prof. Mockeridge, who in co-operation with the architects, Sir Percy Thomas and Son, planned the new Natural Sciences Building. This building, sited on a western extension of the Singleton Park campus, is based on an H plan, the centre and main block of which has recently come into full use and is briefly described below. This building is the first in a completely new College lay-out, the planning of which has been made possible by generous grants of land by the Corporation of Swansea. The construction of stage I, for which Demolition and Reconstruction, Ltd., London, were main contractors, was made possible by a capital grant from the University Grants Committee.

The new building provides accommodation for the four Departments, together with a joint natural sciences library and a large joint lecture theatre. The library, large lecture theatre, centre staircase and cloakrooms are grouped around the main entrance axis. The Departments of Geology and Geography

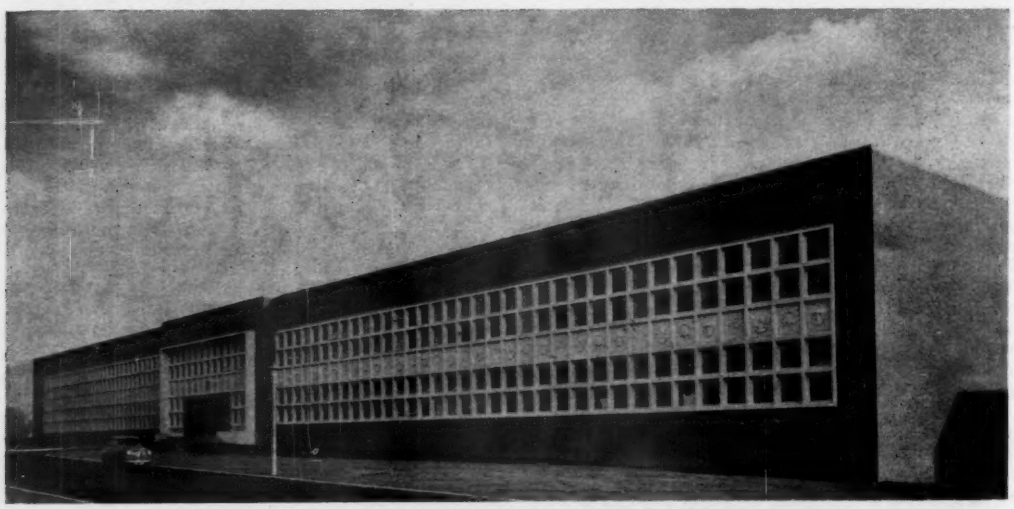

Fig. 1. North face of new laboratories

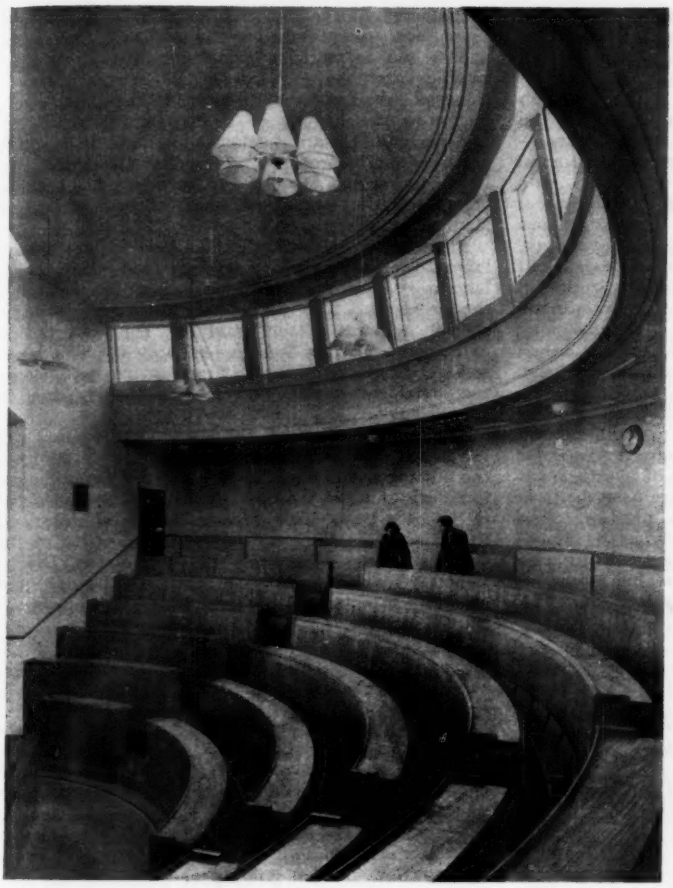

Fig. 2. General view of joint lecture theatre

occupy the first floor, the Departments of Botany and Zoology the ground floor. A semi-basement houses a range of service and storage rooms, the botany and zoology museums, and the geochemistry laboratories.

The architectural plan is based on a 4-ft. module within a 12-ft. structural grid giving a high degree of flexibility and allowing future adjustment of non-structural walls within the module. The building is steel framed with a centre row of columns giving a depth of approximately 24 ft. to the main laboratories and other rooms on the north side, a corridor of 7 ft. and a depth of approximately 16 ft. to the south side rooms. The cladding of the building is an 11-in. cavity brickwork with a buff facing brick. The windows are constructed in a 4-ft. grid with artificial Portland stone mullions and transomes. The panels in between the ground and first floor windows have a repetitive low relief design representing the four sciences.

The building is generally heated by means of aluminium ceiling panels which also give the ceiling high acoustic properties. The main laboratory floors are of cork tiles finished with plastic sealer. The interior finishes of the working rooms and corridors are in pastel colours of emulsion paint. In the corridors and laboratories of the Geography and Geology Departments, large illuminated wall areas are cork-panelled for map displays. The entrance hall is in travertine marble and displays the commemorative stone laid by H.R.H. the Duchess of Gloucester on June 29, 1955. The staircases are in coloured terrazzo with non-slip inserts. The metal work throughout has an anodized aluminium finish. The laboratory furniture is in polished hardwood with Burma teak tops to most working benches. In the Botany and Zoology Departments under-bench cupboard units are provided for each student; these units can be readily moved and fixed at any position along the working benches. Corridor doors are glazed to their full length in Georgian wired glass, eliminating the necessity of borrowed lights in the corridors and enabling the back-walls of the laboratories to be fully used for shelf-fittings and cupboards. Water, electricity and gas are laid to all laboratories; the honours and research laboratories in the Botany and Zoology Departments are in addition supplied with compressed air and vacuum. Artificial illumination is effected by the combined use of tungsten filament and daylight fluorescent lights. In the teaching laboratories of the Botany Department bench-mounted adjustable fluorescent lights give even, shadowless, illumination over all working surfaces at an intensity suitable for microscopy. In the Geography and Zoology Departments each student place is provided with a counterpoised bench lamp. Special protected lights illuminate the vapour hoods and fume-cupboards.

The accommodation for the Department of Geology comprises two general teaching laboratories, one for palæontology and stratigraphy and the other for petrology and mineralogy, an honours laboratory, a geochemistry laboratory, a general research laboratory, staff research rooms, lecture room, workshop, photographic, rock-preparation and other service rooms. The geochemistry laboratory is equipped with complete apparatus for petrographic analyses. New apparatus for current researches in micro-palæontology and sedimentary petrology has also been included in the new building. The circulating hall on the first floor is designed to serve as a temporary geology museum and is being furnished with special display cabinets. A large store-room fitted with tiers of dust-proof drawers houses the extensive departmental collections, including a wealth of research and type material from the South Wales coalfield.

The accommodation now available to the Geography Department consists of a large general laboratory, an honours laboratory, lecture theatre, dark rooms, workshop and cartography room, a joint Geography–Geology Map Library and individual staff rooms.

The good map collection has recently been supplemented by a gift of 3,500 maps from the Directorate of the Colonial Survey. The Department is well equipped in surveying, photogrammetric, meteorological and cartographic apparatus. The research interests of the Department are reflected in the special options offered in the honours course—geomorphology, climatology, cartography, historical geography and economic geography.

The Department of Botany is provided with general and honours teaching laboratories, a museum and herbarium, research laboratories for plant physiology, biochemistry and mycology, staff research rooms and a range of service rooms. A well-equipped workshop and a set of four controlled environment rooms are shared with the Zoology Department. The mycology research laboratory is provided with terrazzo bench tops and with sterilizing and aseptic-transfer rooms. The main research proceeding in this laboratory is a study of vascular parasitism, particularly as exemplified by *Verticillium* species. The research laboratories for plant physiology are specially designed for studies involving the aseptic culture of plants, plant organs and tissues. Extensive use has been made in these laboratories of acid-resistant plastics. The main group in plant physiology is studying the growth and metabolism of plant roots, using the techniques of excised root culture. The staff research rooms are currently being used for radioisotope analysis, enzymology, biochemistry and plant and soil analysis. These facilities are linked to the studies in root metabolism and to work in algal physiology, microbial genetics and the ecology of *Eriophorum*. Hand-coloured plant drawings, pictures depicting landmarks in the history of botany and portraits of famous botanists are displayed in the main corridor and teaching laboratories. These have been given by Prof. Mockeridge, Boots Pure Drug Co., Ltd., Parke Davis and Co., Ltd., and the Wellcome Historical Medical Museum.

The Zoology Department has two large teaching laboratories, a museum, a seminar room, soil ecology laboratory, staff research rooms, aquarium and other service rooms. The soil ecology laboratory contains special apparatus for studying the distribution and metabolism of soil invertebrates. The main research activities of the staff are in marine biology, terrestrial, freshwater and marine ecology and in parasitology.

The field studies of the four Departments are facilitated by the location of their new building in the 50-acre site of wooded parkland adjoining Singleton Park and less than 300 yards from the foreshore of Swansea Bay. This location has as its hinterland to the east the Vale of Glamorgan, to the west the Gower Peninsula and to the north the Brecon Beacons—regions of great natural beauty and scientific interest.

OBITUARIES

Sir William Wright Smith, F.R.S.

Sir William Wright Smith, Queen's Botanist in Scotland, regius keeper of the Royal Botanic Garden, Edinburgh, and regius professor of botany in the University of Edinburgh, died on December 15.

A farmer's son, he was born in Lochmaben, in Dumfriesshire, on February 2, 1875. Thus he had the inestimable advantage of a close connexion with the countryside from his earliest youth onwards. He always delighted in the things of the country and frequently in conversation he would refer to rural scenes and pursuits. Often he proudly claimed to be an accomplished Border shepherd, and few following him on a Scottish hillside would care to deny his physical ability at least.

Wright Smith's start on the long pathway to eminence in the botanical world must date from the day in 1891 when, as a young lad of some sixteen years, he left Dumfries Academy as first university bursar and journeyed to the University of Edinburgh to embark on the course leading to a degree in arts. While pursuing these studies he completed also the diploma course at Moray House Training College for Teachers, for his intention at this time was to enter the teaching profession. He was always a great teacher, and a multitude of students, even those who by the regulations governing the degree they sought were compelled to take botany, will remember his lectures if only for the force of his personality, which made them share the abounding interest he felt in the subject.

After graduation in 1896 he was appointed a teacher, chiefly of secondary subjects, under the Edinburgh School Board. From this point until 1902 he engaged on routine class-work during the day, but in all his free moments he interested himself much and actively in matters scientific, particularly botanical. So much enthusiasm did he show that the then professor of botany, Sir Isaac Bayley Balfour, asked the young man to leave the school room and come to him as assistant in the University Department of Botany.

Thus started a long personal association between the two men, and as it developed so was the hand of Bayley Balfour seen guiding and training the man he intended as his successor. Now the younger man was given every sort of teaching experience—large classes and small, and subjects from the cryptogams to the flowering plants—and always he was closely and personally associated with the older man in the research they both loved.

In 1907 Wright Smith was appointed to take charge of the Government Herbarium in Calcutta. During the stay of some four years he now made in the East, experience in the widest field—administration of a cinchona plantation and direction of a large garden, work in a large national herbarium on a flora from almost every kind of habitat—was pressed on him. Most valuable of all was the opportunity to make botanical explorations in the high Himalaya. The sphere of this work was chiefly independent Sikkim and the borders of Nepal, Tibet and Bhutan. In 1909 he traversed the then practically unknown area of Llonakh on the Tibetan frontier north of the Kangchenjunga glaciers—two months were spent at an altitude from 14,000 ft. to the limit of vegetation. In 1910 the high Himalaya forming the boundary between the Tibetan valley of Chumbi and Eastern Sikkim was the scene of that year's exploration and yielded vast quantities of material for study later on.

All this time, close contact was maintained between India and Edinburgh, so that in 1911 when Bayley Balfour called upon Wright Smith, he was wonder-

fully equipped to come back to the Edinburgh Garden, this time on the staff of H.M. Office of Works as deputy keeper.

Up to this stage his published work had not been voluminous, but now a flood commenced. Descriptions of new species and new genera came quickly. Soon the interest tended to canalize in *Primula* and *Rhododendron*. With more and more material pouring in from the travels of George Forrest and others, Edinburgh was soon forced into the front rank of those centres where plant systematy received most attention.

In 1922 Sir Isaac Bayley Balfour resigned from his dual appointment and Wright Smith took over the duties of the University chair and the keepership of the Garden—both Crown appointments. Thus he laboured for thirty-four years—he was among the last, if not quite the last, professor to receive his appointment in Scotland "for life while of good conduct". He taught his classes with ever-welling enthusiasm, inspired his joint staff to new exertions, and all the time dealt with the multifarious affairs of a large busy botanical garden. With all this he carried on his research in his beloved genus *Primula*.

Space precludes more than the merest mention of the many other facets of the man and his career—his love of games (beating youngsters at chess or tennis in his last decade); his joy in company and the stories he told; his deep love of India and the Indians (all from that continent were Indians, partition was in neither his vocabulary nor his geography).

He was created knight in 1932 and was elected Fellow of the Royal Society in 1945. Among many other honours he was an honorary LL.D. of Aberdeen and D. ès Sc. of Toulouse. He was awarded the Victoria Medal of Honour by the Royal Horticultural Society in 1925 and succeeded Dr. A. B. Rendle as the Society's professor of botany in 1938. He was also president of the Royal Society of Edinburgh during 1944–49.

Sir William Wright Smith will be mourned deeply by very many, and his work will provide an enduring memorial. He is survived by his widow and three daughters.

ALEXANDER NELSON

Brigadier W. H. Evans, C.S.I., C.I.E.

BRIGADIER WILLIAM HARRY EVANS belonged to that rapidly dwindling band of army officers who turned to natural history as a hobby while serving in the Indian sub-continent, and in the process added significantly to our knowledge of its fauna and flora. The son of General Sir Horace Evans, he was born in Assam in 1876. Educated at King's College, Canterbury, he joined the Royal Engineers in 1894. He served with the Somaliland Field Force in 1903–4 and throughout the First World War, sustaining injuries in both campaigns. Though he made light of these, they did in fact increasingly handicap him in later years. He died after a short illness on November 13.

Throughout his service in India, Evans collected butterflies assiduously, eventually presenting his entire collection to the Trustees of the British Museum. His keenly analytical mind, however, soon rebelled at the inconvenience of the literature available which, though voluminous and often profusely illustrated, was scattered and costly and largely devoid of a comparative element. Soon after publishing an account of the butterflies of the Palni Hills and a most useful "List" of the butterflies of India, he embarked upon a thorough taxonomic overhaul of the Rhopalocera of India, Burma and Ceylon. His results were published in instalments in the *Journal of the Bombay Natural History Society*, and afterwards re-issued in book form in 1927. These "Keys for the Identification of Indian Butterflies", though at first sight disconcerting, due to systems of numbering and abbreviation of Evans's own devising, proved so practical and popular that a second edition was called for in 1932. In a single handy book of 300 pages, illustrated by thirty-two not at all beautiful half-tone plates, they gave the student just that essential information which he would fail to find in the ten large volumes of Moore's "Lepidoptera Indica". These "Keys" have proved invaluable, and at family and generic level useful beyond the range of their immediate objective.

On retirement in 1931, Evans devoted himself voluntarily to the single task of applying his methods to the taxonomic revision of the Hesperiidae or 'Skippers' of the world, a group worthy of his metal that had hitherto defied all attempts at a satisfactory natural classification, due less to the very large number of species concerned than to the remarkable uniformity of the morphological characters most easily used in classification. His results were published by the Trustees in a series of "Catalogues of the Hesperiidae in the British Museum", issued in 1937 (Africa), 1949 (Europe, Asia and Australia) and 1951–55 (America). During the course of this work Evans must have examined upwards of half a million specimens and, because his classification is largely based on the external male genitalia, dissected a large proportion of them. To achieve this in the time at his disposal he had to use methods less elaborate than ideal, and there is no doubt that a more leisurely re-examination of his results will lead to considerable revision in detail. Nevertheless, he did for the first time apply critically the same standards to the whole family in assessing the taxonomic values of morphological characters. Such a consistent application of uniform criteria has produced for the first time in this most difficult but attractive family an orderly and, one believes, natural arrangement of strictly comparable units which is unlikely to be superseded for many years and from which further research can proceed. He himself would have been the last to claim that he had achieved finality.

Evans's numerous entomological friends in Britain and abroad will feel his loss for many years to come; but he has at least left them a massive and characteristic contribution of lasting value by which to remember him.

N. D. RILEY

Prof. St. Maziarski

PROF. ST. MAZIARSKI, a well-known Polish histologist, died in Cracow on July 7, 1956, at the age of eighty-three. He was the initiator of the so-called Cracow school of histology and worked chiefly in the field of the cytology of glands and the microscopical anatomy of the muscular tissue. He was the pupil of the French histologist, A. Prénant, and a friend of P. Bouin. All his life he was connected with the Jagellonian University of Cracow; for several periods he served as dean of the Medical Faculty, and he was rector of the School during 1933–36.

JADWIGA ACKERMANN

NEWS and VIEWS

Institution of Electrical Engineers : Awards

HONORARY membership of the Institution of Electrical Engineers has been conferred on Sir Noel Ashbridge, a past-president of the Institution, in recognition of his distinguished services to the Institution and his outstanding contributions in the field of radio engineering, particularly in the development of the British sound and television broadcasting services; and on Sir Harold Hartley, in recognition of his life-long interest in all aspects of engineering science, and for his studies of the conservation of natural resources. Dr. Waldemar Borgquist, lately president of the Swedish State Power Board, has been awarded the Faraday Medal of the Institution for his outstanding contributions to the development of electricity supply and transmission, particularly at extra-high voltages, and for his long-standing interest in the education and training of engineers.

Dr. C. P. A. Waldemar Borgquist

DR. BORGQUIST, who was born at Malmö in 1882, graduated at the Royal Institute of Technology in Stockholm in 1903 and received further training with the Luth and Roséns Electrical Co., Stockholm, and Siemens–Schuckert Werke in Berlin. In 1908 he was appointed plant engineer at the Trollhättan Power Station, and in 1911 became head of the Power Station Section of the Swedish State Power Board, becoming head of the Power Board in 1938, an appointment which he held until his retirement in 1947. Dr. Borgquist has been an outstanding figure in the development of extra-high voltage a.c. for power transmission and played a major part in inaugurating the work which culminated in the Sweden–Gotland 100-kV. d.c. cable. He has always interested himself in the rising generation of engineers and has made it one of his main concerns that they should have adequate facilities for education and training.

Royal Aircraft Establishment, Farnborough : Dr. H. M. Wilson, M.B.E.

DR. H. M. WILSON, whose promotion to chief scientific officer and appointment as deputy director-general of aircraft equipment research and development has been announced by the Ministry of Supply, graduated with honours in electrical engineering at the Queen's University, Belfast, in 1932 and obtained his Ph.D. for the study of transient phenomena on high-voltage transmission systems in 1934. He was apprenticed with Fairbairn Lawson Combe Barbour, Belfast, and later took a college apprenticeship with Metropolitan-Vickers, Manchester. In 1935 Dr. Wilson joined the Royal Air Force Educational Service and served at Halton, St. Athan and at the Ministry of Supply Establishment at Fort Halstead before becoming senior education officer of the Empire Air Armament School, Manby. He made a special study of the problem of the remote control of guns in aircraft and the control of missiles. Dr. Wilson was appointed superintendent of control in the Guided Projectile Establishment, Westcott, in 1947, and later transferred to the Royal Aircraft Establishment, Farnborough, to lead the guidance and control division of the Guided Weapons Department. He was appointed head of the Armaments Department in 1949 and promoted to deputy chief scientific officer in 1950.

Dr. S. Jones

DR. S. JONES, whose promotion to deputy chief scientific officer and appointment as head of the Armaments Department of the Royal Aircraft Establishment in succession to Dr. Wilson has also been announced, was educated at University College, Cardiff, and later at the University of Birmingham. He graduated with first-class honours in engineering in 1932 and obtained his Ph.D. in 1950. During 1933–46 Dr. Jones was employed at the Witton branch of the General Electric Company and then engaged in teaching until the Second World War, when he joined the headquarters staff of the Ministry of Aircraft Production. After the War, Dr. Jones was appointed to the Radar Research Establishment, Malvern, where he worked on servo-mechanisms and became particularly interested in the optimization of servo design in the presence of noise. This interest largely arose from work with Prof. A. Tustin at Birmingham on the design of a servo-controlled photographic plate carriage for the new Isaac Newton telescope at Herstmonceux. Dr. Jones afterwards led a team concerned with the application of infra-red techniques and was promoted to senior principal scientific officer in 1952. He became head of the Defensive Airborne Radar Division at the Radar Research Establishment in 1954 and held the post until his present appointment.

Deputy Director of Air Armament : Mr. N. Coles

MR. NORMAN COLES has been appointed to the new post of deputy director of air armament at Ministry of Supply Headquarters. Mr. Coles, who is forty-two, took a mathematics degree at the Royal College of Science and afterwards attended the postgraduate aeronautics course at the Imperial College of Science and Technology. He joined the Royal Aircraft Establishment at Farnborough in 1936 and, after a short period devoted to the study of methods of making our balloon barrage defences more lethal, commenced work on the development of electronic proximity fuses for bombs. His achievements in this field, which resulted in the first use of proximity fuses in warfare in 1942, were recognized by an award to him by the Royal Commission on Awards to Inventors. In 1942, Mr. Coles turned his attention to various problems of aircraft gun and rocket sighting, and in 1944 had a period of operational research work with the Allied Expeditionary Air Force Headquarters at Stanmore. Towards the end of the Second World War, he entered the new field of guided weapons at the Royal Aircraft Establishment, Farnborough, and was first concerned with the study of various possible weapons systems and with organizational and similar problems arising from this new departure. In 1948 he became head of the Guided Weapons Trials Division at Farnborough and was responsible for the development of the many new techniques required in the flight-testing of guided weapons. In 1951 he was transferred to Ministry of Supply Headquarters as the assistant director concerned with the more scientific aspects of air armament. In his present post he will concentrate on the development of new weapons for the Royal Air Force. Mr. Coles has taken part in several missions abroad; in 1945 he was a member of the first guided weapons mission to the United States and in 1946 was one of the team which visited Australia for discussions which led to the setting up of the Woomera Range.

Controller of Guided Weapons and Electronics : Dr. R. Cockburn, C.B., O.B.E.

DR. R. COCKBURN, whose appointment as controller of guided weapons and electronics was announced in October, is the first scientist to hold a post of controller in the Ministry of Supply. He entered the Scientific Civil Service in 1937 at the Royal Aircraft Establishment, Farnborough, as a member of the team engaged on the development of very high-frequency communications for the Royal Air Force. During 1939–45 he was at the Telecommunications Research Establishment as head of the Radio Countermeasures Division. This division was responsible for countering the German navigation systems over Great Britain and for the interception and analysis of their radar systems. Later the division developed for Bomber Command airborne and ground equipment to counter the German air defences. This work culminated in an elaborate system of diversion decoying and jamming in support of the invasion of Europe. During 1945–48 Dr. Cockburn was in the Nuclear Physics Division at the Atomic Energy Research Establishment at Harwell and for a short time at Chalk River. In 1948 he became scientific adviser to the Air Ministry and held this post until 1954, when he returned to the Ministry of Supply as principal director of scientific research (guided weapons and electronics). He became deputy controller of electronics in 1955. Before entering Government service, Dr. Cockburn taught physics at West Ham Municipal College and was engaged in research on transit time effects in valves. He published papers in the *Proceedings of the Physical Society*. As a result of this work he was awarded the Ph.D. degree of the University of London in 1939. He was appointed O.B.E. in 1946 and C.B. in 1953. In 1947 he was awarded the American Congressional Medal for Merit for his work in the field of radio warfare.

Ageing and Industry

A STATISTICAL inquiry into the age-composition of workers in the British iron and steel industry has been carried out by C. Fleming, of the Department of Social and Industrial Medicine at the University of Sheffield. Not unexpectedly, the investigation shows that the work-population has 'aged' over the past two decades and that there is considerable variations between the age structure of various companies and between firms in different centres of the country. Investigation has also been made into the age structure of different sections of the iron and steel industry and, surprisingly, shows that blast furnaces have the greatest percentage of older men in the industry, while foundries, which have had recruitment difficulties, have almost the lowest. Apart from a plea for the establishment of a science of gerontology, the author makes few suggestions of any practical value to those in the industry, who must have been impressed by the extensive nature of this statistical inquiry. Mention might have been made of the adjustments necessary within the industry to meet trade union insistence on promotion by seniority and of the difficulties which the iron and steel industry, in common with others, will have to overcome in providing adequate training schemes for those 'extra' youths of the war-time birth-rate 'bulge' who will shortly begin to leave school. Their employment will cause considerable change in the industry's age structure over the next ten years.

Philosophical Outlook of Mansel

IN "The Religious Philosophy of Dean Mansel" (Friends of Dr. Williams's Library, Tenth Lecture, 1956. Pp. 24. London: Oxford University Press, 1956. 3*s*. 6*d*. net), Dr. W. R. Matthews, Dean of St. Paul's, discusses the philosophical outlook of one of the most interesting (and perhaps among the least appreciated) of his predecessors. Mansel's Bampton Lectures of 1858 opened up a deep argument with F. D. Maurice, which touched the roots of epistemology. Briefly, it is held that there is an almost complete barrier between theology and philosophy (the latter, for Mansel, is no sort of serving-maid to the former), whereas Maurice, in his dislike of all systems, appears more liberal in maintaining the wholeness of knowledge. The essentially static nature of theology as propounded by Mansel is characteristic: for him it is not a science at all, and quite incapable of producing any progressive cognition of the Divine. Dr. Matthews is certain that he would have rejected any alleviation of his metaphysical *impasse*, having no more use for the *analogia entis* than Karl Barth has now for it in his 'crisis theology'. Yet Mansel's type of agnosticism stops well short of Otto's 'wholly other', and asserts man's mental limitations as the decisive factor. In all, a clear and concise summary of a significant movement, not without consequence for contemporary thought.

Scientific Research in British Universities

A FURTHER edition of "Scientific Research in British Universities", compiled by the Department of Scientific and Industrial Research (pp. vii+372. London: H.M. Stationery Office, 1956. 21*s*. net) from material collected by the British Council from heads of university departments, gives notes on scientific research in progress in British universities and university colleges during the session 1955–56 in sufficient detail to indicate the scope of activity of the department and of each research team. Only those researches are included which were actively pursued during the session, or on which information has been published by the staff of the department within the past four years, or in which the head of the department normally accepts research students. The entries are arranged alphabetically by universities, and there are also name- and subject-indexes.

Commonwealth University Interchange

THE Committee for Commonwealth University Interchange set up in 1948 to facilitate the movement within the Commonwealth of university teachers and graduates has published a report on its eight years work. A total of 389 visits has so far been arranged and 89 universities and university colleges from the United Kingdom, Canada, Australia, New Zealand, South Africa, India, Pakistan, Malta, Ceylon, Hong Kong, Malaya, Singapore, Gold Coast, Nigeria, East Africa and the West Indies have participated, the participants ranging from vice-chancellors and scholars of international repute to young postgraduate workers at the outset of their academic career. The demand for the awards expanded throughout the period covered by the report and requests for awards for the academic year 1956–57 represented a maximum. Lists of awards in each of the three categories are appended, together with an analysis of the distribution by universities and by centres. The scheme appears to have fulfilled at least in part the aims of its promoters, but the £12,583 available for 1955–56 was sufficient to meet

only a modest portion of the demands made on the scheme.

Bedgebury National Pinetum and Forest Plots

In 1924 it was decided to form a new pinetum to supplement that in existence at Kew, the latter being threatened by industrial expansion and increasing pollution of the air, and the new pinetum was established at Bedgebury, Kent. Bedgebury Forest lies in undulating country in the eastern part of the Wealden district of south-east England—a pleasant country, the lower levels having good fertile soils, which are well farmed, and the upper areas being well wooded. The pinetum originated under the auspices of the Royal Botanic Gardens and the Forestry Commission, and a committee was set up to manage the place, comprising members of both bodies. Sir Geoffrey Evans, chairman of this committee, writes the foreword to a small pamphlet entitled "Guide to the National Pinetum and Forest Plots at Bedgebury", issued by the Forestry Commission (second edition. Pp. 68+8 plates. London: H.M.S.O., 1955; 3*s*. 6*d*. net). The guide contains a handy plan which enables the visitor to find his way about with ease. The present plantings were undertaken in 1925 by W. Dallimore, who supervised the work until 1945, and the large collection of conifers which has been assembled in the pinetum is largely due to his unfailing energy and enthusiasm. When he relinquished the post of honorary curator, he remained on the committee, where his advice is of value. Since 1948 the pinetum has been under the care of a resident supervisor, who is also responsible for the forest plots. A car-park is available for visitors, whose numbers far exceed those with specialized interests in the pinetum or the forest plots. It is for this reason that the guide has been published. The pinetum is near London and is a most useful adjunct to Kew that should appeal to all lovers of the Royal Botanic Gardens.

Bardsey Observatory

Despite considerable financial difficulties, the Bardsey Bird and Field Observatory continues to make progress and, in its second annual report, accounts are given of numerous activities which took place in 1955. This privately owned island lies off the Montgomeryshire coast and, during the year, attracted student parties as well as a number of individual visitors. Besides many ornithological studies, visitors carried out observations on the earthworms and the littoral and sublittoral marine algae of the island. The report may be obtained from the honorary secretary, Mr. W. M. Condry, Eglwysfach, near Machynlleth, Mont.

Ejection Theory of the Formation of Meteor Showers

Miroslav Plavec, of the Astronomical Institute of the Czechoslovak Academy of Sciences, Prague, in a paper on the "Orbit of an Ejected Meteor" (*Bull. Astro. Inst. Czech.*, **6**, No. 2; 1955), investigates the perturbing effect of the Earth upon meteors ejected by a comet, the ejection occurring, in most cases, in the vicinity of perihelion. In these circumstances the comet's orbital velocity exceeds 30 km./sec., and a velocity of ejection less than 3 km./sec. is assumed; on physical grounds, it is believed that velocities greater than this are improbable. The theory is developed and then applied to three meteor showers—the Geminids, Draconids and Lyrids—and it is assumed that all available directions of ejection are possible. The deviations from the elements of the new orbits are extremely small except in the case of the period of revolution, and, in addition, the differences in the perihelion passages accumulate in time, so that meteors are rapidly separated from the comet. The most interesting of these three showers is the Draconid shower, associated with comet Giacobini–Zinner, and it is shown that a meteor ejected with a velocity of only 10 m./sec., in the direction of motion of the comet, returns to perihelion eleven days later than the comet. After about seven revolutions such a meteor would be as far from the comet as the meteors were when observed during the 1933 shower —that is, eighty days. It is also shown that small differences of ejection velocities between individual meteors would produce a dispersal along the orbit, and here is seen that general tendency of an ejected meteor cloud to form a fairly homogeneous ring along the whole orbit.

Co-ordinates of Venus

As the result of a scheme undertaken in 1947 by the Yale University Observatory, the Watson Scientific Computing Laboratory, and the United States Naval Observatory, with the object of improving our knowledge of the motions of the principal planets, the Naval Observatory has prepared a set of "Co-ordinates of Venus, 1800–2000", published as Vol. 15, Part 3, of "Astronomical Papers prepared for the Use of the American Ephemeris and Nautical Almanac" (Washington, D.C.: Government Printing Office, 1956; 2.50 dollars). The determination of the masses of certain planets and of improved values of certain fundamental astronomical constants was an important part of this undertaking, and for this purpose it was necessary to trace the orbits of selected minor planets with high precision throughout the period since their discovery. Precise co-ordinates of Venus were essential for calculating the action of this planet on these selected minor planets, and it is explained in the preface why Newcomb's tables were both inconvenient and unsuitable for the accuracy required. The completion of the extensive calculations at the Cincinnati Observatory was made possible through a generous grant from the International Business Machines Corporation, and this grant provided for an installation of punched-card equipment devoted exclusively to scientific computation. Additional equipment for this project was obtained by contract with the Mathematics Division of the Office of Naval Research. Details of the method of computation, etc., with formulæ and numerical examples, are provided in the publication. The heliocentric co-ordinates of Venus are given from Dec. 27·5d., 1799, to Dec. 22·0d., 2000, Julian Days 2,378,492·5 to 2,451,692·5. The longitude is given to mean equinox of date and also to equinox 1950·0, and the latitude to the ecliptic of date and to the ecliptic of 1950·0. In addition, the radius vector and rectangular co-ordinates (equinox and equator 1950·0) are given to seven decimal places.

Vacuum in Metallurgy

A. A. Vertman and L. M. Novik (*Priroda*, No. 9, 81; 1956) give an account of laboratory and industrial experience in the smelting and casting of metals under vacuum. It is a well-known fact that many defects of cast metals are due to the occluded or dissolved gases, such as nitrogen, oxygen and hydro-

gen. Attempts to remove these gases by the addition of silicon, aluminium, titanium and other metals which combine with the gases, produce slags which are often difficult to separate from the metal, and are often harmful to the refractory lining of the furnace. Subjecting metals to vacuum conditions removes these gases as well as gaseous carbon compounds. The process is based on the fact that the solubility of gases in metals is directly proportional to the gas pressure in the system. Satisfactory degasification does not necessarily require a high degree of vacuum, and good results were obtained at 1–0·01 mm. of mercury. Besides small-scale operations on high melting-point metals and their alloys, large-scale production of cast steel under vacuum conditions has been successfully tried in the U.S.S.R. About fifteen years ago A. M. Samarin and L. M. Novik designed a vacuum installation for large steel containers and ingot moulds. This process is particularly important in the case of Bessemer steel operations, in which degasification for ten to fifteen minutes reduces the amount of nitrogen by 30–50 per cent and the amount of oxygen by a factor between 4 and 10.

Metallurgy and Ceramics in the United States

Since 1950 the number of graduates in metallurgical engineering and ceramics in the United States has fallen by half, and although some 500 graduate annually in metallurgical engineering, on a conservative estimate 1,000–1,500 are required annually for the next five years. The American Society of Metals, the American Ceramic Society and the American Institute of Mining, Metallurgical and Petroleum Engineers have accordingly appointed a special committee on man-power for the metallurgy and ceramics professions which has already organized three study groups. One study group is exploring the possibility of a national scholarship programme in industry and the others will seek to make more information available about the opportunities in these professions at high-school level and to adult education organizations.

Archives of the Royal Society

A guide to the archives of the Royal Society and to other manuscripts in its possession, prepared by Mr. R. K. Bluhm for *Notes and Records of the Royal Society* (August 1956), has been reprinted and issued as a pamphlet. It gives a general summary of the Society's archives and the other manuscripts in its possession, showing in what manner they are catalogued and what form the catalogues take. The word 'archive' is construed to mean any minute of a meeting of the Society, its Council or its committees; any letter or document addressed to or coming from the Society or its officers in their official capacity; any list or schedule of its property and any ledger or register of its books, instruments or the like. The non-archive manuscripts consist chiefly of collections of the correspondence of men of science, and various miscellaneous items. The guide is not in general concerned with material dating from the present century. Brief descriptions of the main series or collections of manuscripts are included.

V. H. Blackman Research Studentships

The East Malling Research Station Association has instituted the annual award of a research studentship which should be of considerable interest. These studentships, named after Prof. V. H. Blackman in recognition of his outstanding services to the Research Station for more than forty years, and of the great influence he exerted upon the developments of studies in the physiology of crop plants, have a value of £500 a year (tax free). They are tenable at East Malling Research Station and will provide unusually wide opportunities for training in the research methods appropriate to research on perennial fruit plants. At East Malling there are nine well-equipped research sections (pomology, statistics, physiology, biochemistry, fruit nutrition, plant analysis, plant pathology, entomology, and plant protective chemistry), and it is intended that the students shall develop their scientific experience on as wide a basis as possible during their three years tenure. It is hoped that these studentships will provide a most fruitful impetus towards enhanced collaboration between crop research stations and university departments, as well as extending the opportunities of training and research for young graduates of outstanding merit.

Announcements

Sir Ian Clunies Ross, chairman of the Commonwealth Scientific and Industrial Research Organization, Australia, has been awarded the Gold Medal of the Royal Agricultural Society of England. The Medal is awarded from time to time "for distinguished services to agriculture either in practice or in science". The award carries with it honorary membership of the Society.

Dr. L. E. Orgel, assistant director of research in the Department of Organic and Inorganic Chemistry (Sub-Department of Theoretical Chemistry), University of Cambridge, has been awarded the Harrison Memorial Prize for 1956 of the Chemical Society, in consideration of his contribution to the development of theoretical chemistry published during the five years 1952–56.

The following appointments in the University of Leeds have been announced: Mr. C. J. Black, to be senior agricultural economist in the Department of Agriculture; Mr. I. Codd, to be lecturer in the Department of Metallurgy; Dr. E. W. Worrall, to be lecturer in ceramics in the Department of Gas Engineering and General Fuel Science with Ceramics.

Sir Lawrence Bragg will deliver the fourth Trotter-Paterson Memorial Lecture to the Illuminating Engineering Society at the Royal Institution on February 11. The Lecture is entitled "Some Experiments on the Interference of Waves". Tickets can be obtained from the Secretary, Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

Applications are invited for the Kathleen Schlesinger Fellowship, tenable at the National Hospital for Diseases of the Nervous System, London. Preference will be given to candidates proposing to investigate degenerative diseases of the brain and central nervous system, including biochemical abnormalities if so desired. The stipend will be within the range £700–£1,000 per annum. Further details can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

Erratum.—In the obituary notice of Mr. John Evershed in *Nature* of December 15, p. 1323, the maiden name of Mr. Evershed's first wife is given incorrectly; she was Miss Mary Acworth Orr.

TENTH INTERNATIONAL CONGRESS OF ENTOMOLOGY

THE Tenth International Congress of Entomology, which took place in Montreal, Canada, during August 17–25, 1956, was perhaps the largest gathering of entomologists ever held. More than fourteen hundred members attended, of whom 1,140 were from North America and 280 from overseas; among the latter, the British group was the largest (65), followed by France, West Germany, the Netherlands and Japan. The Soviet Union sent seven delegates, and Poland, Bulgaria, Romania and East Germany were represented. With the exception of China and of parts of South America and the Near East, the Congress attracted a world-wide membership.

Both McGill University and the University of Montreal provided accommodation. The Congress was generously supported by the Government of Canada, by the Province of Quebec, several other provinces and the City of Montreal, and also by the United Nations Educational, Scientific and Cultural Organization, the Canadian Pulp and Paper Association, and many other commercial and learned organizations. It thus became possible to offer considerable financial assistance to many overseas entomologists. A gratifying result of this was that one hundred and fifty members took part in the post-congress tours and about seventy others visited laboratories independently, giving visiting scientists the opportunity to see something of the remarkable increase in entomological effort in Canada since the War.

The Congress, under the presidency of Dr. W. R. Thompson, comprised fifteen sections with some seven hundred and twenty papers and many exhibits and films. Comment on this wealth of material must be restricted to relatively few items.

The one general session was introduced by a recorded address from Dr. Karl Jordan, the founder (in 1910) and honorary life president of these congresses. Dr. Jordan, now ninety-five, had attended all previous meetings. Then followed the presidential address on "The Interpretation of Taxonomy" and papers by Dr. Pierre Maillet (France) on *Phylloxera* and by Prof. O. W. Richards (Great Britain) on "The Science of Ecology".

A group of sessions on systematics was devoted to individual orders of insects. At a symposium on the attributes, variation and taxonomy of the species, E. O. Wilson (United States) discussed the tendency of related species to differ more markedly where they become sympatric; W. J. Brown (Canada) described his work on sibling species in the Chrysomelidae; W. L. Brown (United States) considered successive expansion and contraction of range and its effects on gene flow and speciation; and R. L. Usinger (United States) discussed the ecology of closely related sympatric species in the light of Gause's and Nicholson's studies of competition.

The section on genetics, cytology and biometrics included a symposium on the genetics of insect populations, with contributions from C. L. Remington (United States) on Lepidoptera, G. Stehr (Canada) on sex-limited dimorphism, J. C. King (United States) on DDT-resistant strains of *Drosophila melanogaster*, and Elisabeth Goldschmidt (Israel) on natural populations of *Drosophila subobscura*. A strong group of cytological papers included contributions by T. Yosida (Japan) on autosome–sex chromosome relationships, Ann Sanderson (Great Britain) on *Ptinus latro*, and Sally Hughes-Schrader (United States) on the deoxyribonucleic acid content of the nucleus. The applications of cytology and genetics to taxonomy received special attention from G. K. Manna (India), D. Leston (Great Britain), G. Cousin (France), and several Canadian workers. There was a lively biometrics section, with considerable discussion following the papers.

In the section devoted to geographical distribution, papers analysing the composition of regional faunas were prominent. For example, J. L. Gressitt (Hawaii) showed that the fauna of New Guinea had an ancient south-east Asian origin, but was isolated more markedly than at present through most of the Tertiary and produced a high degree of endemism. W. Förster (Germany) showed that the Altiplano and high mountains of Bolivia have strong holarctic affinities, while the lower lying areas have a neotropical fauna of complex origin. The most important group of papers, however, was the symposium on the distribution of arctic and sub-arctic insects, held jointly with the section on systematics. There was much discussion of the terms 'arctic' and 'sub-arctic', and some discrepancies in their usage. The dividing line is sharply correlated with the tree line in Canada, but not in Alaska or Europe. C. H. Lindroth (Sweden) demonstrated that the greatest barrier to dispersal in Pleistocene and recent times has been the Davis Strait. A series of papers on individual groups included a noteworthy account of arctic blackflies by G. E. Shewell (Canada); W. R. M. Mason (Canada) discussed distributional problems in Alaska, and A. B. Klots (United States) southward extensions of the arctic fauna. The symposium ended with papers on the origin of the arctic fauna by G. Warnecke (Germany) and E. G. Munroe (Canada). There were in all nineteen contributions, but unfortunately none relating to the great Siberian sector of the arctic.

In the section on morphology and anatomy the relationship of insects to other arthropods was discussed at length. G. F. Ferris and F. M. Butt (United States) and E. M. Du Porte (Canada) approached the question through analyses of the segmental constitution of the head. R. E. Snodgrass (United States) considered the structure of the tentorium and its antecedents in Crustacea and Myriapoda. S. L. Tuxen (Denmark) assembled the evidence concerning the position of the Protura; he concluded that they should be regarded as true insects, most closely related to the Diplura. E. Handschin (Switzerland) did the same for the Collembola but arrived at rather different conclusions—that the Collembola, Protura and Diplura are more closely related to the Myriapoda than to the Insecta.

Among other interesting contributions, G. Richard (France) described the growth of Johnston's organ in termites and phasmids and traced the changes that occur during the moult. C. Noirot (France) showed that rudiments of the gonoduct of the opposite sex exist in young nymphal termites, confirming Heymons's (1895) work on embryos of cockroaches. S. Kramer (United States) showed that the wing muscles of *Periplaneta americana* are opaque and pink in the males but hyaline and white in the non-flying females, and related these differences to the metabolism and mechanism of flight.

In the palæontology section, B. B. Rohdendorf (U.S.S.R.) outlined recent studies of the rich Carboniferous and Permian insect beds in southern Siberia; 262 species of 12 orders have been described, the Cupedidae and the Curculiopseidae (Coleoptera) being particularly abundant. Four faunas can be distinguished and compared.

Papers on the Arachnida were not numerous, but included interesting contributions on the phylogeny and taxonomy of the Acari. A. Shulov (Israel) described the production of spermatophores in scorpions, but the way they are transferred to the female remains uncertain; and G. W. Byers (United States) showed that in *Trombicula* also insemination is by an external spermatophore.

Physiology and toxicology, one of the strongest sections of the Congress, included sessions on neuromuscular systems and insecticidal activity, temperature effects, the sensory and nervous systems, nutrition, problems of metabolism, periodic phenomena and resistance to insecticides. The symposium on the nature, origin and activity of insect hormones attracted contributions from D. Bodenstein, Berta Scharrer and C. M. Williams (United States), V. B. Wigglesworth (Great Britain), P. Karlson (Germany), B. Possompès (France), A. F. O'Farrell (Australia), D. M. Steinberg (U.S.S.R.) and M. Ichikawa (Japan).

H. A. Schneiderman (United States) showed that the spiracles of the *Cecropia* moth behave as independent effectors sensitive to carbon dioxide and oxygen, and release respiratory carbon dioxide in periodic bursts. B. N. Smallman (Canada) discussed the inhibition of cholinesterase by organo-phosphorus compounds, and A. G. Richards (United States) contributed a notable paper on the effect of temperature on organ- and enzyme-systems. E. Hecker (Germany) reported the isolation and identification of the sex-attractant of the female silkworm and established a unit on behavioural criteria.

In the behaviour section, Ilse Schwinck (Germany) complemented Hecker's paper by her account of activation and orientation of male moths by the sex odours. V. G. Dethier (United States) described the rudimentary dance performed by blowflies after feeding, and suggested the existence of a general pattern of insect behaviour that bees have perfected as a means of communication. D. Magnus (Germany) showed a film illustrating his analysis of the mating of *Argynnis*, and J. A. Downes (Canada) discussed the mating of Nematocera and the correlated modifications in the behaviour, ecology and sensory equipment of aberrant species. J. S. Kennedy (Great Britain) described observations on aphids that lend support to an emended chain-reflex theory of instinct.

The sessions on social insects were sponsored jointly with the International Union for the Study of Social Insects and included some twenty papers. C. D. Michener (United States) considered that social behaviour in bees originated from interrelations among the adult insects, contrary to Wheeler's theory. J. S. Moure (Brazil) showed that colony multiplication in the Meliponini involves transport of materials from the mother colony before and after the flight of the young queen. T. Eisner, W. L. Brown and E. O. Wilson (United States) discussed food-sharing and the evolution of ants, paying special attention to the functions of the proventriculus. A. E. Treat (United States) gave a fascinating account of the sub-social mite *Myrmonyssus*, which colonizes one only of the paired tympanic organs of moths. In a session devoted to nest structures, the paper by P. P. Grassé and C. Noirot (France) on termites was especially noteworthy.

An important group of papers distributed between ecology and forest entomology were concerned with the fundamental causes of numerical variation of populations in Nature. A. D. Voûte (Netherlands) and G. C. Varley (Great Britain) argued in a general way for the view that populations are regulated by factors the destructive intensity of which varies with population density, increasing as the density rises, decreasing as it falls; A. Milne (Great Britain) held that the numerical variations are due to chance, and the fact that numbers may be maintained at a reasonable constancy by random factors was shown in an interesting statistical experiment by F. Schwerdtfeger (Germany); L. C. Cole (United States), in a paper which aroused great interest, showed that series of numbers selected at random have often a distinctly cyclical character, suggesting the existence of rhythmically acting natural factors which do not in fact exist; and that there may also be numerical correlations completely devoid of factual significance.

The forest entomology programme also included sessions on insect surveys, chemical control, and forest management problems. Other papers discussed the problems of particular areas and reported studies of the ecology, natural and chemical control, and hazard appraisal of forest insects in many parts of the world.

Appropriately, several papers concerned the spruce budworm, the insect of perhaps the greatest significance in the Canadian economy. R. F. Morris analysed life-tables and discussed population dynamics; the very large-scale aerial spraying operations in the Maritime Provinces and in Oregon were considered by F. E. Webb and J. M. Whiteside, respectively; and the point of view of industrial management on cultural control was ably presented by B. W. Flieger.

The well-attended sessions on biological control, with ninety-one papers from twenty-four countries, were a remarkable indication of current interest. A series of papers was devoted to reviews covering the broad field over much of the world. Two long symposia on orchard mites and their natural control and on the biological control of the balsam woolly aphid included specialist contributions from many parts of Europe and North America. A session on insect pathology and another on the utilization of micro-organisms also brought to light much interesting information and showed how fungi, bacteria and viruses, as well as nematodes, have become more conspicuous among the beneficial organisms used. Other subjects treated at length included the control of weeds, the role of ants in biological control and adaptation by parasitic insects.

The section of agricultural entomology, the largest in the Congress, devoted seven meetings to special topics. The tension between the method of chemical control on one hand and the ecological approach and the need for conserving valuable natural enemies on the other was prominent in the sessions on locusts and grasshoppers, on contrasting approaches to orchard entomology, and on soil insects, all of which drew many distinguished contributions. B. A. Porter (United States) reviewed recent work on the fruit fly problem in temperate regions, and L. D. Christenson (United States) showed that attractants, especially protein hydrolysate and poisoned methyl

eugenol, are proving valuable in the tropics. There was an important session on insect transmission of viruses, with the papers equally divided between entomologists and plant pathologists, and a detailed examination of the international and legal problems arising from insecticide residues. Advisory entomology, the United States technical assistance programmes, recent advances in insecticide application and the problems of special crops were also considered.

In the relatively small section on stored products entomology, the international problems arising from the variation in storage facilities and from the movement of insect-infested produce were examined by S. S. Easter (United States) and J. A. Freeman (Great Britain). Contributions by R. W. Howe (Great Britain) on the potential range and importance of the Khapra beetle, and by H. M. Armitage (United States) on methods of eradication, proved to be of such general interest that an additional session was organized. Other papers described new methods of detecting hidden infestation in grain, new fumigation techniques, and problems of storage in warm climates.

In the section on medical and veterinary entomology, symposia were held on the entomology of filarial infections, on animal viruses in arthropods, and on the biology and control of blackflies. In the first two the speakers concentrated on the arthropod vectors, what happens in them when infected, their biology and how this affects epidemiology. The blackfly papers reported advances made in Africa, Central America, the United States, Canada and Great Britain. Malaria and its vectors were discussed in papers from the World Health Organization and from India, Africa, Vietnam, Timor and elsewhere. Other papers on vectors and disease dealt with mites and scrub typhus in Malaya, ticks and tick paralysis in Canada, and problems resulting from the development of water resources in the United States. There were small groups of papers on the biology of cattle warbles and their control with systemic insecticides, on *Phlebotomus*, and on techniques for artificial feeding of blood-sucking arthropods. Other contributions of note concerned the periodicity of biting-fly attack in the U.S.S.R. and in Africa, and the transmission of blood parasites of ducks by *Culicoides* and of snakes by the mite *Ophionyssus*.

The discussions on apiculture ranged over nectar secretion, the composition of honey, and the behaviour, physiology and diseases of bees. A series of papers considered the pollination of fruit and legume crops by *Apis* and wild bees. R. Chauvin (France) reported that intra-muscular injection of royal jelly in man induced neutropenia and reticulocytosis, accompanied by a pronounced euphoria. Some 200 kgm. of royal jelly is harvested annually in France for therapeutic use.

I am greatly indebted to the leaders of the sections for assistance in compiling the foregoing account.

At the closing session of the Congress, Prof. A. da Costa Lima, of Brazil, and Dr. J. Chester Bradley, of the United States, were elected honorary members. Mr. N. D. Riley resigned as secretary of the Permanent Committee, and Dr. D. J. Kuenen, of the Netherlands, was elected in his place. It was decided to hold the eleventh congress in Vienna in 1960.

The Proceedings of the Congress, which will include most of the papers presented, will be published shortly. Inquiries should be addressed to J. A. Downes at the Science Service Building, Ottawa, Canada.

J. A. Downes

CAMBRIDGE OBSERVATORIES

REPORT FOR 1955

THE report of the Observatories Syndicate of the University of Cambridge for the year ending September 30, 1955*, deals first with solar research, and under this heading reference is made to Dr. H. von Klüber's work in completing and discussing the interferometric photographs of the green coronal line 5303 A., made in co-operation with Dr. A. H. Jarrett, of the University of St. Andrews Observatory, at the total eclipse of June 30, 1954. From measurements made in the range 1·05–1·3 solar radii, and interpreting the line widths as due entirely to thermal motions, temperatures of the corona were found around $2 \cdot 2 \times 10^6$ to 5×10^6 °K., most of the values being near $2 \times 5 \times 10^6$ °K. The results were so encouraging that preparations were made to observe the June 20, 1955, eclipse at Hingurakgoda, using more extensive equipment; but unfortunately clouds prevented any results of scientific value being obtained by any of the eclipse expeditions to Ceylon. Dr. D. E. Blackwell has completed measurement and reduction of the corona photographs obtained by him at the 1954 eclipse, and a first paper was ready for publication when the report was compiled.

Dr. von Klüber has discovered that the large Mount Wilson diffraction grating, which gives a measured resolving-power of about 600,000 in the fifth order, allows remarkably clear visual observations of a fine structure of Fraunhofer lines, consisting of shifts and distortions arising from the solar granulation. The effects are seen in varying degrees in nearly all lines of the solar spectrum, but are most conspicuous in the hydrogen lines. Examination of the fine structure, using an electro-optical shutter of the A.D.P. type, failed to detect any local magnetic fields, but Dr. von Klüber and Dr. B. E. J. Pagel have started further work on this question. Various other matters are referred to in the report under solar research, among which may be noticed the balloon project mentioned in earlier reports. Dr. D. W. Dewhirst and Dr. Blackwell, by arrangements made through the Royal Society for co-operation with the Royal Air Force, made four flights in a Lincoln aircraft, and photographed the Sun, through an open door, with a 7-in. refractor. Owing to vibration, but still more to air disturbance set up by the machine, it does not appear that high-resolution photographs of the Sun are likely to be obtained from conventional aircraft.

In the section dealing with the 17-in. Schmidt telescope, reference is made to the work of Dr. Dewhirst, assisted by G. G. Yates and A. N. Argue, in searching with the instrument for discrete radio sources. Using blue-sensitive plates going to a limiting magnitude about 18·5, a small number of faint galaxies have been detected the positions of which agree with radio sources of small diameter, but otherwise no peculiar stellar or extragalactic object has been found in the positions given. In addition, photographs in the blue, and with a plate filter combination for Hα, have given no evidence to support the idea that either Hii regions or clusters of galaxies are responsible for the majority of sources of large diameter. Workers at the Cavendish Laboratory have found a significant correlation between the

* University of Cambridge. Report of the Observatories Syndicate for the Year ending 1955, September 30. (Cambridge: The University, 1956.)

positions of radio sources and those of known astronomical galaxies. Photography of a selected number of suspected galaxies from the international catalogues reveals that some show peculiar structure or are members of small clusters.

The erection of the 36-in. reflector with adjustment and testing has been completed; the telescope was designed for use either at the prime focus, at $f/4{\cdot}5$ or at a fixed coudé focus, to which the light travels along the polar axis northwards, using a three-mirror combination giving $f/18$ or $f/30$. Mr. G. G. Yates designed a photoelectric stellar photometer embodying a quartz monochromator, which allows simultaneous measurement of the brightness of a star in three regions of wave-length which may be selected at will. The photometer will be used at the coudé focus of the 36-in. telescope and was approaching completion when the report was compiled.

NATIONAL PHYSICAL LABORATORY, TEDDINGTON

REPORT FOR 1955

THE annual report for 1955 of the National Physical Laboratory, Teddington*, describes the wide range of research and test work carried out during the year. It contains the report of the Executive Committee which was presented to the meeting of the General Board held on May 25, the annual open day of the Laboratory (see *Nature*, 177, 1151; 1956); a note by the then director, Sir Edward Bullard, describing his own individual researches and the publications of the administrative staff; and detailed individual reports, prepared by the respective superintendents, of the activities of the ten Divisions and Test House of the Laboratory. The frontispiece consists of a reproduction of the portrait (painted by Bernard Dunstan) of Sir Edward, which was presented to him by his colleagues on the occasion of his resignation of his appointment after serving as director since 1950, and which now hangs alongside portraits of previous directors in the large conference room of the Laboratory.

The Executive Committee reports that it again gave its attention, when reviewing the research programme, to the desirability of reducing the number of research items so that effort could be concentrated on new and important work. The increase in staff allotted to the Laboratory under the plan for a five-year limited expansion of the Department of Scientific and Industrial Research was allocated mainly to the Aerodynamics and Ship Divisions, and the personnel and much of the equipment of the Metal and Fatigue Group of the High Temperature Mechanical Properties Section were transferred to the Mechanical Engineering Laboratory, East Kilbride. Work on the site for the new Ship Hydrodynamics Laboratory at Feltham was commenced in March 1955, and the casting of the main tank sections were expected to be completed before the end of 1956. The tank will be 1,300 by 48 by 25 ft., and its carriage will have a maximum speed of 50 ft./sec. A steerage and storage basin, a new water tunnel, a workshop, foundry and machine shop facilities will also be provided.

* Department of Scientific and Industrial Research. National Physical Laboratory: Report for the Year 1955. Pp. viii+110+7 plates. (London: H.M.S.O., 1956.) 5s. net.

Two international symposia were held during 1955 at the Laboratory, one in March on "Boundary Layer Effects in Aerodynamics" and the other in September on "Cavitation in Hydrodynamics". The proceedings of the symposia on "Engineering Dimensional Metrology", held in October 1953, and on "Precision Electrical Measurements", held in November 1954, and four new booklets, Nos. 9–12, in the series "Notes on Applied Science", were published during the year. In addition, the proceedings of the 1953 symposium on "Automatic Digital Computation" was reprinted twice; No. 3 in the series of "Units and Standards of Measurement" was reprinted; and a total of no less than 156 scientific papers were contributed by members of the staff of the Laboratory to various journals and periodicals.

The two industrial and scientific liaison officers have continued to bring to the notice of industry the research and development proceeding in the Laboratory. More than sixty firms were visited, and special tours were arranged in Scotland and South Wales. 106 lectures were given by other members of the staff to scientific and similar organizations. The Laboratory exhibited several items at the Physical Society's annual exhibition of scientific instruments and apparatus, the Engineering and Marine Exhibition and the British Instrument Industries Exhibition. Visitors to the Laboratory included parties from the Soviet Academy of Sciences, the International Electrotechnical Commission and from the joint meeting of the Iron and Steel Institute with the American Society of Metals and the American Institute of Mining and Metallurgical Engineers. Sir Edward Bullard delivered the Scott Lectures at Cambridge, in which he reviewed existing knowledge of the interior of the Earth and the theory of the solid state used for extrapolating results obtained in the laboratory to the much higher pressures occurring in the interior of the Earth, and he represented the Department of Scientific and Industrial Research at the international symposium on the utilization of solar energy held in Phoenix, Arizona. Thirty-eight members of the staff made official visits overseas, and details of these, with the usual lists of members of the general board, executive committee and sub-committees, the positions and names of the senior staff, and bibliographies of the publications of the director and members of the staff of the Divisions of the Laboratory, are included in the annual report.

The individual reports of the various sections of the Laboratory reveal that a wide range of interesting and important investigations has been undertaken. The greater part of the work of the Aerodynamics Division is devoted to fundamental research on behalf of the Ministry of Supply, and the range of problems continues to increase, largely because of the increasing speeds attained by aircraft and missiles. In addition to investigations of high-speed flow, however, many low-speed investigations of swept-back wings and of methods of boundary-layer control designed to provide increased lift were also carried out. Other work not connected with aeronautics was concerned with such problems as the stability of suspension bridges, television masts and other structures, air flow over the decks of ships and the design of wind tunnels.

The digital electronic universal computing engine (DEUCE), an improved version of the pilot model of the ACE (automatic computing engine), was installed

during the year, and the Control Mechanisms and Electronics Division is continuing with the development of the full-scale ACE, which is estimated to be at least four times faster than DEUCE or the pilot model. The electronic simulator of the Division continues to be used for the study of automatic control and other problems involving the solution of differential equations, and the work of the Electronics Section has included the development of a stable power-supply unit for the Electricity Division, the provision of acoustic equipment in the lecture hall and the construction of part of a special, highly accurate, camera-shutter system for the Admiralty. In the Electricity Division the cæsium atomic beam standard of frequency and time interval has been completed, and an experiment similar to the Michelson–Morley 'ether-drift' experiment, but using short radio-waves within a cavity resonator instead of light waves, has been carried out. The result obtained supports the principle that there is no drift effect.

The diverse activities of the Light Division have had many industrial applications. The Merton–N.P.L. processes for the preparation of diffraction gratings are gradually being taken over by commercial organizations. New methods of producing plastic replica gratings have made it possible to prepare accurate gratings up to several feet in length, and work on the application of diffraction gratings to linear measurements included a thorough theoretical investigation into the theory of moiré fringe formation, which has now been published. The Division has also developed ultrasonic equipment for cutting slots in thick glass plate and for drilling tungsten carbide, and two new types of thin-film bolometers are being developed to meet the industrial need for sensitive non-selective detectors of infra-red radiation.

The tracer laboratory in the Metallurgy Division came into full operation during the year, and useful results were obtained from the application of a variety of experimental techniques to the problem of fatigue in metals. On behalf of the Fire Research and Building Research Stations, an investigation was made of the loss of stress, under the action of fire, in steel reinforcing bars used in pre-stressed concrete. Good progress is reported by the Metrology Division in the development of two impersonal methods of measuring line standards of length. Improved light sources for optical interference measurements of length have been explored, and interferometry is being applied to a re-determination of the velocity of microwaves to one part in a million. A new determination of the absolute value of gravity is being undertaken in order to improve the accuracy with which the pressure exerted by a barometric column is known in absolute units and also to improve the realization of the ampere. The experiment will consist of throwing a ball up vertically and timing its motion as it first rises and then falls over a measured distance. The new primary barometer is reported to be almost complete.

In the Physics Division significant progress has been made on the extension of measurements of thermal conductivity to low temperatures, on greater accuracy in mercury thermometry, on the international comparisons of the standard apparatus for determining the röntgen for X-rays up to 300 kV., and on a new method for the precise measurement of high pressures with the piston balance. The film dosage service which has been operated by the Radiology Section of the Division for many years is to be transferred to the Radiological Protection Service, operated jointly by the Ministry of Health and the Medical Research Council. A scheme for the provision of liquid helium, prepared in the Laboratory's Collins liquefier, to various universities and laboratories was started during the year, but the demand so far has been rather limited. The Mathematics Division has been able to devote more time to research problems and less to the demands of outside organizations. DEUCE was used for the solution of hyperbolic and parabolic differential equations, nuclear scattering problems and the calculation of molecular integrals, and a new method employing Chebyshev series was developed. The Ship Division was mainly responsible for organizing the symposium on cavitation, and its research work has largely been concerned with ship/model comparison and the study of frictional resistance. A very useful method of controlling manœuvrable models by radio in the Division's tank was developed.

The report concludes with details of the various tests carried out by the Test House of the Laboratory.

THE 'GREEN POOL' AND HORTICULTURAL MARKETING

THE growing interest in the possibility of European agricultural integration reveals more and more clearly the lack of comparative information needed to answer many of the fundamental questions raised by the cases for and against this 'Green Pool'. In no part of European agriculture and its associated industries is that statement more true than in the marketing of fruit and vegetables. Not only are there extremely few studies of horticultural marketing in individual countries, but comparative data for the non-Communist European countries have until now been virtually non-existent in a readily accessible form.

The situation has been greatly improved by the publication of "The Marketing of Fruit and Vegetables in Europe" by the Organization for European Economic Co-operation*. This report contains much descriptive and statistical information relating to the economic organization of horticultural marketing in thirteen countries. Subject to any subsequent revisions, it will remain a standard reference for many years. Some of the information is superficial, but there is much that will help satisfy the needs of administrators and research workers concerned either with technical or economic aspects of the industry in countries other than their own, especially if inter-country studies are planned. The degree of detail is of necessity often restricted, but a wealth of pointers and introduction to topics of considerable interest is provided. For example, there are useful references to the French Government's powers to plan the development of the main wholesale markets and of its Fonds de guarantie et d'orientation de la production agricole, an agency aiming in time to reduce price fluctuations of fruits and vegetables. A more sophisticated arrangement already operating to achieve the same objective is the Dutch price insurance scheme, and the report contains one of the few existing descriptions of it in English.

* Marketing of Fruit and Vegetables in Europe. (Project No. 249 C.) Pp. 328. (Paris: European Productivity Agency of the Organization for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 600 francs; 12s.; 2 dollars.

The completeness of the statistical information varies considerably for different countries and crops; it covers production, the timing of harvest periods, levels of consumption, imports, exports and distribution costs. For the economist this last set of information is the most interesting, but it is tantalizingly deficient. The Italian data seem the most detailed and accurate, whereas for most other countries the evidence shows the inadequacy of our present knowledge. Yet the intra-European comparison of marketing costs is a most fruitful point of departure for any study of the relative efficiencies of the various systems described.

A real deficiency of the report is its tendency to reflect excessively official thinking. For example, the Dutch price insurance scheme has one serious defect, namely, that prices to growers are maintained by restricting total sales in the fresh fruit and vegetable markets and by destroying surplus supplies in some instances. This is not made clear. Similarly, the discussion on grading programmes in the British section contains no reference to the extremely successful private grading schemes that have been introduced by individuals or by groups of growers, particularly in apple and pear production. Yet the private development of fruit and vegetable grading has achieved more than has the public sponsoring of it, and there are good theoretical reasons for expecting such a result in Britain. Another important omission is the lack of reference to the 1950 Census of Distribution in the discussion of British costs of marketing. Therefore, the high value of the present survey must not hide the fact that it is not a complete guide to the many and diversified facets of horticultural marketing in various parts of Europe.

GEORGE ALLEN

THE FUSED SILICA INDUSTRY IN BRITAIN

THE fascinating story of the birth and progress during the past fifty years of the fused silica industry in Great Britain is told in an illustrated volume produced by the Thermal Syndicate, Ltd., in commemoration of the jubilee of incorporation of the company*. The three parts into which the volume is divided deal respectively with the history of the Thermal Syndicate, Ltd., during 1906–17; the Silica Syndicate, Ltd., a parallel organization, during the same period; and the post-1917 company, the Thermal Syndicate, Ltd., formed from the amalgamation of the two earlier syndicates.

In 1902, Mr. (later Sir) Richard Paget, a London barrister, when on a visit to the home of the first Lord Rayleigh, was shown a small quartz tube which Lord Rayleigh's son was building-up by fusing together little pieces of quartz crystal, a process evolved by Mr. W. A. Shenstone, a master at Clifton College. His interest thus aroused in fused silica, Paget together with Lord Armstrong, and C. Merz and W. McLennan who were on the look-out at the time for new uses for electric power, formed a private syndicate in order to carry out research, with Dr. F. Bottomley in charge, on the electric fusion of silica (sand). Bottomley, in 1903, successfully produced his remarkable 'Ostrich Egg', and the manufacture of fused silica tubes and ware for sale was begun. Finally, on August 3, 1906, the Thermal Syndicate, Ltd., was incorporated as a private company with an authorized capital of £10,000.

The Syndicate's factory consisted of a small wooden building and office space was provided by Merz and McLennan in their Wallsend Laboratories. A quite separate but parallel organization, the Silica Syndicate, Ltd., was formed also in 1906. This had the backing of Johnson, Matthey and Co., Ltd., and was to exploit the manufacture of the 'transparent' form of fused silica made from quartz (rock crystal) as distinct from silica material made from sand. The growth and development of this syndicate were particularly associated with the mercury vapour lamp and the silica radio transmitting valve. In 1917 the two syndicates were merged into the Thermal Syndicate, Ltd., and with the transfer of the Silica Syndicate's plant and key workpeople to Wallsend in 1920 the whole of the fused silica industry of Britain became concentrated in one place.

The basic Thermal Syndicate patents expired in 1921 and several factories for manufacturing fused silica were established in Europe, but, in general, the British processes were copied. 'Optical quality' transparent fused quartz for use as lenses and prisms was first developed during the 1930's, and in addition at this time the company decided to enter the field of high-temperature refractories in materials other than silica, alumina and magnesia being chosen as the first to be developed. The demand for both the new products and fused silica equipment in the chemical and electrical industries and other projects during the Second World War rose to new heights, and since the War new output records have been achieved.

New agencies have been created, notably in Australia and Belgium, and the Thermal Syndicate, Ltd., has now many accredited agents in all parts of the world, including the subsidiary Thermal American Fused Quartz Company in the United States of America. It is interesting to note that the connexion with Johnson, Matthey and Co. is still maintained, with G. C. H. Matthey as the present chairman of directors of the Thermal Syndicate, Ltd.

* The Story of the Thermal Syndicate, Limited. Pp. xiv+48+13 plates. (Wallsend: The Thermal Syndicate, Limited, 1956.)

MESOANALYSIS IN METEOROLOGY

RESEARCH Paper No. 39 of the United States Weather Bureau, entitled "Mesoanalysis: an Important Scale in the Analysis of Weather" (pp. 84. Washington, D.C.: Government Printing Office, 1956; 50 cents), by Tetsuya Fujita, H. Newstein and M. Tepper, describes an investigation into the detailed structure of a depression in the Middle West of the United States using observations at stations spaced at distances of the order of 25–30 miles. This is termed analysis on the meso-scale as distinct from the macro-scale of the ordinary weather map, on which the spacing of stations is at distances of hundreds of miles, and the micro-scale, on which the spacing is less than ten miles. This work, carried out by the Severe Local Storms Research Unit of the Weather Bureau, is stated to have shown that local weather is more closely connected with features on the meso-scale than those of the macro-scale. 195 stations in ten States centred on Kansas were used, 67 of them regular reporting stations and 128 subsidiary stations, partly voluntary observing ones.

Upper wind and radar cloud and precipitation observations were made at some stations.

A detailed description is given in the paper of the events associated with the south-eastward movement of a cold front on June 24 and 25, 1953. Charts are presented with isobars at ½-mb. intervals, isotherms, winds and weather. They reveal the existence of small low- and high-pressure centres having diameters of tens of miles, often arranged in pairs of high and low centres called 'pressure couplets'. Tornadoes and very strong winds occurred near some of these couplets. Ahead of the cold front in the warm air the pressure-jump line was found along which pressure rose very sharply. The main cold front of the ordinary weather-map macro-scale analysis did not appear on the meso-scale as a continuous line separating the warm and cold air masses but as a frequently changing set of systems, though it could at times be identified as a continuous line of change of wind direction and concentration of isotherms. Some meso-systems were found to be arranged along the cold front rather like sea waves on a sloping beach.

The account is purely descriptive and no attempt is made to explain dynamically the weather experienced. Since the barographs and thermographs of the subsidiary stations were not periodically checked and the stations measured rainfall at 24-hr. intervals, special techniques for reducing their pressure and temperature observations to sea-level and obtaining hourly amounts of rain were devised using interpolation between the observations of the regular stations. The development of this valuable work will be watched with interest by all meteorologists.

EARTHQUAKES DURING MARCH—SEPTEMBER 1956

DURING the period March to September 1956 inclusive there were forty-seven earthquakes in the world of magnitude 6 and greater. The greatest of these attained magnitude 8, and, as has already been reported in *Nature*, took place on July 9 with an epicentre in the Aegean Sea. It is reported that several towns were destroyed on the islands of Thira and Ios, and that forty-two people were killed. Two earthquakes attained magnitude 7¼. The first of these occurred on June 9 in Afghanistan. In the Kunhar valley several villages were buried under debris crashing from the mountains into the valley. In this valley one hundred and fifty people were killed and more than a thousand injured. In the Shaigan valley one hundred and sixty people were killed and more than a thousand injured. Many aftershocks occurred. The second earthquake of magnitude 7¼ occurred on July 18 with an epicentre in the Banda Sea.

On July 21 an earthquake was experienced in western India from Rajkot to Bombay. Most damage was done at Anjar some 30 miles east-south-east of Bhuj, the capital of Kutch. More than a thousand buildings in Anjar, including the post and telegraph office, were destroyed. Landslides and other surface damage disrupted communications. More than a hundred people were killed and many more injured near Anjar. In and around Bachau also two hundred houses were wrecked. On July 16 an earthquake in central Burma caused major property damage at Mandalay and Sagaing. Thirty people were killed. Earthquake damage is also reported on March 16 in southern Lebanon (*Nature*, 177, 560; 1956); March 31 in Hungary; April 19 in Spain and September 29 in Japan.

European earthquakes were experienced on March 24 in Switzerland; June 2 in Italy; June 10 in Austria; June 28 in Jugoslavia; June 30 in the Black Sea near Romania; August 1 in the Zollern Alps, and on August 16 near the south-west coast of Portugal. On March 16 an earthquake was felt with intensity 6 on the modified Mercalli scale in Galilee.

British earth tremors occurred on May 4, July 9, July 28, August 5 and August 23. The shock of May 4 was felt near Ipswich and heard at Bury St. Edmunds, Felixstowe and Framlingham. It was recorded at Kew, Durham, Paris, Rathfarnham (near Dublin) and Upsala (Sweden). From some of these records the observers at Kew determined the epicentre to be at 52·1° N., 01·6° E., which is just off the coast near Ipswich. The initial time was 23h. 25m. 50s. G.M.T. The shock of July 9 was felt at Chester, Kelsall, Blacon and at Woolstanwood near Crewe. Mr. E. F. Baxter, of the University of Durham, determined the epicentre to be at 33° 10′ N., 02° 55′ W., which is some four miles west of Chester. The initial time was 01h. 01m. 33s. G.M.T. The other three British shocks were near Tarbert in Argyll. The first was felt on July 28 at 21h. 40m. near Tarbert, and at Carse and Glenbranter between the head of Loch Eck and Loch Fyne. The second, on August 5 at 13h. 40m., is reported from Carse. The third, on August 23, was the greatest. It was felt over a wide area around Tarbert, including Carse, Clachan (a village in Kintyre, five miles from Carse), Whitehouse, Campbeltown, Rhu, Lochgilphead, Ardrishaig and Glenbranter. The Rev. R. E. Ingram, *S.J.*, is of the opinion that this was the earthquake which was recorded on the seismograms at Rathfarnham Castle near Dublin at 16h. 32m. 04s. G.M.T. Unfortunately the shock was not recorded at the British seismological observatories, since it was not of sufficient magnitude.

PUBLISHING IN BRITAIN

BROADSHEET No. 392, "Publishing and Bookselling" (Political and Economic Planning; 2*s.* 6*d.*), deals with publishing, bookselling, distribution and the present state of the market. The output of new titles has steadily risen since 1950 from 17,072 to 19,962 in 1955, of which 5,770 were reprints and new editions. Turnover has also steadily increased, from £37,158,652 to £46,270,953, of which 35·7 per cent is for export, compared with 30·7 per cent in 1950. Most of the business is in the hands of the 370 firms who are members of the Publishers' Association and are responsible for at least 90 per cent of the turnover, the largest output coming from H.M. Stationery Office, with 1,380 titles. Next come Collins (529); Oxford University Press (389); Hutchinson (364); Heinemann (266); Longmans (266); Macmillan (241); and Hodder and Stoughton (221).

It is difficult to get any idea of the true economic state of the publishing industry, for almost all the firms are private companies which do not publish their accounts. Printing and binding costs are now

nearly three times the 1939 price and paper is almost five times the pre-war figure. A sample survey made by the Publishers Association in 1953 put these three items at 28 per cent of the published price of general books and fiction, and at the beginning of 1956 many publishers received notice of a 15 per cent increase in printing charges. Book printing is only about 8 per cent of the total output of printing in Britain and has to compete with larger and more profitable custom. Large editions are now the order of the day wherever possible, and it has been suggested that the main hope for economy in binding lies in the reduction of the number of processes by use of thermoplastic adhesives in place of sewing and in greater standardization.

Most new books are subject to the Net Book Agreement and a discount of 33⅓ per cent is commonly allowed to booksellers on fiction and general books, with up to 25 per cent on specialized technical, legal and medical books. Even with the former, many booksellers claim it is almost impossible to pay their way on new books, and throughout 1955 the book trade was obliged to concentrate on the problem of the wholesaler. When Simpkin Marshall, Ltd., ceased trading on March 30, 1955, a serious gap was created in the distributive machinery of the book trade, which has not yet been filled. The Net Book Agreement was modified in the first National Book Sale of February 1955, and this successful experiment was repeated in 1956.

Educational publishing is a highly specialized section of the trade with which about 80 members of the Publishers Association are concerned. Expenditure on books by the 577 public library authorities increased from £2,305,000 in 1950–51 to £3,180,000 in 1954–55, partly owing to increased prices. Most business is still done through bookshops, and a survey of readers' methods of selecting their books carried out by Harrap last year indicated the importance of reviews. There is a general impression that the traditional book market is changing fast and annual analyses made by *The Bookseller* indicate that books on trade, industry and commerce are now nearly eight times the pre-war figure and increased by more than 50 per cent in 1955 alone. Technical handbooks are nearly treble the pre-war figure, as are topographical books, and books on art and architecture have more than doubled. Fiction is now only 18·5 per cent of the total compared with 30 per cent in 1937, although it still forms the largest section.

BRITISH VITAL STATISTICS FOR 1953

THE General Register Office has recently published the text commentary on the vital statistics of 1953 (Registrar General's Statistical Review of England and Wales for the Year 1953. Text volume. Pp. xv+250. H.M.S.O., 1956. 9*s*.). It follows the traditional pattern associated with these volumes and contains sections dealing with the total population, fertility, marriage and divorce and mortality. No noticeable changes occurred in 1953. Births were fractionally larger than in the previous year, and the fertility rates were just sufficient for population replacement. The increase in fertility was mainly concentrated at marriages of medium duration, which had taken place between 1948 and 1953, but the authors do not believe that these slight increases herald any change in completed family size.

The total number of marriages has decreased, but this is largely due to the depletion of the number of unmarried people in the population. When related to the unmarried, the marriage-rate remains high, and is about 10 per cent above the pre-war level, and there is a continuing increase in marriages at younger ages. As a result of the high marriage-rates in the past, the ratio of married women aged 15–49 to all women in that age group has reached a record value of 678 per thousand. Divorces appear to be running at about 30,000 per year, and the re-marriage-rate of divorced persons remained high.

Deaths are now increasing because of the increasing number of old persons in the population, though mortality-rates remain constant. The excess of male mortality over female is growing, particularly at ages between 45 and 85. Infant mortality has fallen slightly, but geographical differentials persist both for infant and adult deaths. Particular attention is given to deaths from tuberculosis and cancer, and it is gratifying to see that the decline in the tuberculosis death rate is continuing.

Perusal of the volume as a whole suggests that the experience of 1953 affords no reason to change previous assessments of the demographic situation of England and Wales.

THE UNIVERSITY COLLEGE OF RHODESIA AND NYASALAND

FOR eleven years, various groups, which often included Africans and Asians, worked, publicized and collected money in East Africa until, as a result of their efforts, nearly half a million pounds was available for the creation of a University College for Rhodesia and Nyasaland at Salisbury. The first groups of buildings have now reached roof height; the arts building and the science research laboratories are nearly complete.

The twelve heads of departments are in Salisbury and at first were concerned with the preliminary planning and equipping of these buildings. Now they have begun to establish their research work; it is a happy circumstance that enables the University College to establish its research activities before its teachers have to receive its first undergraduate students.

The Federation of Rhodesia and Nyasaland, because it is advancing in so many directions at once, offers immense possibilities for research workers in every field of knowledge. This work will be added to the great volume of research already taking place in the Federation; this is undertaken by government departments, industrial and commercial undertakings or special research institutes. The main research projects have been described by the vice-principal, Prof. B. A. Fletcher (*Universities Rev.*, **29**, No. 1).

The more specialist or long-term researches will be undertaken at the University College. An experimental garden of ten acres has been prepared on the University site in order to make possible work in experimental taxonomy. This work will coincide with the preparation, under government sponsorship, of a Flora of the Federation; special attention will be given to those groups difficult to classify by orthodox methods.

The Federation has several specialist problems that may take some time to solve. The effect of fire on high- and low-veld vegetation is a particularly complex problem. Another immediate practical problem is the reason for the special vegetation which develops on termite mounds, and the explanation for the better growth of plants like maize upon them.

In the Department of Zoology, it is hoped to establish a field centre in the Wankie Game Reserve, where work on the systematic study of groups of animals may add to that already done on birds, reptiles and certain groups of insects.

Perhaps the most urgent problem is the control of tsetse fly, for notwithstanding work already done, knowledge of the physiology and natural history of these insects is far from complete. Freshwater biology is another field which is only just beginning to be explored and may yield results of importance to the new industry of fish-farming.

Many of these researches will be linked with the work of the Department of Agriculture of the University College; there will soon be available an experimental and teaching farm in the Mazoe Valley.

A country so rich in minerals as the Federation has indicated two lines of research to the Physics Department of the University. The first is the examination of the structure of metals and alloys by X-ray diffraction methods, and the second is the development of a geophysics research team to apply the special methods of physics to an examination of the geology of the Earth's crust.

Research in the Chemistry Department will be in the field of organic chemistry, and a study of some of the drugs obtainable from the plants of the Federation may be of particular importance.

In the Department of African Studies, the main line of research will be of the changes brought about in both rural and industrial areas where African peoples with many different kinds of social organization and economy are being drawn into a Western cash economy. The part played by schools and educational influences in this change will be studied by the Department of Education as one of a number of its own researches. It is hoped also to extend the work already begun on the recording of African languages and on the psychological studies of African peoples.

In economics the emphasis will be at first on some of the immediate problems of the Federation, such as the balance of payments, income, distribution and various aspects of public finance; but a more long-term study will be that of the problems of economic growth in undeveloped areas.

In all such research the material available at the Central African Statistical Office will be a great asset to guest research workers and postgraduate students. Similarly, the College is fortunate in its nearness to the Central African Archives, the resources of which will be invaluable to research workers in history and archæology.

All this indicates that the University College of Rhodesia and Nyasaland will hold in fair balance its teaching and research activities.

The Royal Charter incorporating the College states that "no test of religious belief or profession or of race, nationality or class, shall be imposed upon or required of any person to entitle him to be admitted as a member, professor, teacher or student of the University College or to hold office therein or any advantage or privilege thereof".

In interpreting the spirit of its Charter, the College itself will be a bold experiment in race relations of a kind that could be carried out nowhere else in the world.

All the early indications are that a university will establish itself there fairly quickly as one with equal-sized groups of Europeans and Africans.

RADIATION DAMAGE IN LANTHANUM MAGNESIUM NITRATE CRYSTALS CONTAINING RADIOACTIVE ISOTOPES

By Dr. B. BLEANEY, F.R.S., Dr. W. HAYES and Dr. P. M. LLEWELLYN
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OBSERVATIONS have been made of the paramagnetic resonance spectrum of lanthanum magnesium nitrate ($La_2Mg_3(NO_3)_{12}.24H_2O$) containing two different radioactive isotopes. In the first case, a single crystal containing about 3 mc. (400 μgm.) of americium-241 was grown in two to three hours from a solution containing about 10 mc. of this isotope, which is a 5·5-MeV. alpha-particle emitter of half-life 470 years. In the second case, a crystal containing about 3 mc. (3 μgm.) of promethium-147 was grown in about a week from a solution containing 5 mc. of this isotope, which emits 0·22-MeV. beta-particles with a half-life of 2·6 years. Thus the crystals and solutions were comparable in activity. With americium, a strong damage spectrum was observed the morning after the crystal was grown, but with promethium no such spectrum was observed until an afternoon some three weeks after the crystal was taken from the parent solution. The spectrum has also been observed in a single crystal of $(La, 10 \text{ per cent } Ce)_2Mg_3(NO_3)_{12}.24H_2O$ which had been subjected to 110 megaroentgens of cobalt-60 gamma-rays. This crystal, initially colourless, became opaque with a light yellow colour, but was the best formed crystal and the most accurate measurements were made on it. When the external magnetic field is parallel to the crystallographic c-axis, the spectrum consists of a three-line hyperfine structure characteristic of a nucleus of spin 1, which can only be nitrogen-14. The line width is about 10 gauss at 290° K. and 4 gauss at 90° K. From measurements in other directions, it is found that there are three types of magnetic centre with different orientations of the principal axes, but with the same

principal values of the g-tensor and A-tensor, as follows:

	Americium compound	Promethium compound	γ-Irradiated compound
x-Axis	$g_x = 2{\cdot}055$	$2{\cdot}005$	$2{\cdot}004$
	$A_x = 64 \pm 3$	63 ± 4	63 ± 1
y-Axis	$g_y = 2{\cdot}005$	$2{\cdot}004$	$2{\cdot}005$
	$A_y = 58 \pm 3$	56 ± 2	57 ± 1
z-Axis	$g_z = 1{\cdot}991$	$1{\cdot}993$	$1{\cdot}994$
	$A_z = 44 \pm 4$	49 ± 4	50 ± 2

(Hyperfine structure constants in units of 10^{-4} cm.$^{-1}$; errors in g-values $\pm 0{\cdot}002$)

The directions of the axes are: y-axis, in plane of hexagonal flat plate which is the normal crystal habit, at 45° to a crystal edge; x-axis and z-axis, in plane through c-axis normal to y-axis, at angles of $16 \pm 2°$ and $74 \pm 2°$ respectively from the c-axis. The three ions are related to each other by 120° rotations about the c-axis.

Details of the crystallography of these salts are unknown, but from paramagnetic resonance experiments on crystals containing copper[1], it is likely that the divalent cations are octahedrally co-ordinated to six water molecules, while similar experiments on crystals with trivalent $4f$-ions[2] show that the line width of the trivalent $4f$-ion spectra is unusually small. This suggests that the trivalent cations, if they have the usual nine-fold co-ordination, must be bonded to nitrate groups rather than to water molecules. A plausible assumption which accords with the chemical formula is that the ligands consist of three water molecules in the plane normal to the c-axis, three $(NO_3)^-$ groups above this plane and three below derived by inversion through the trivalent cation; this would give the C_{3v} symmetry required for the crystal field[3]. Since only three and not six differently oriented magnetic centres are observed, it seems that the full crystal symmetry is retained by the centres, since each of a pair of centres related to each other by inversion would give an identical spectrum.

The magnitude and anisotropy of the hyperfine structure correspond to the magnetic electron being on a nitrogen ion in a $2s$ state and a $2p$ state, each for about one-fifth of the time. It thus must be in a bonding or anti-bonding orbital on some irradiation product of NO_3^-, and we have considered the magnetic properties of N, NO, NO_2 and NO_3. The ground-state of the nitrogen atom is $^4S_{3/2}$, and the free atom[4] has only a small hyperfine structure ($A = 3{\cdot}5 \times 10^{-4}$ cm.$^{-1}$); it seems most unlikely that this would become anisotropic or appreciably larger if the atom is trapped in a solid. A trapped NO molecule would be paramagnetic in the excited $^2\Pi_{3/2}$ state; but this would not be populated at low temperatures and there would be no allowed transitions in a molecule unable to rotate. NO_3^- and NO_3^- are non-magnetic; but either NO_3^{2-} or NO_3 would be expected to give a spectrum. On a rather crude molecular orbital model, however, it turns out that NO_3^{2-} ions, either planar or pyramidal, could give a hyperfine structure of the appropriate magnitude, but with the wrong anisotropy; planar NO_3 groups would give practically no hyperfine structure, because the magnetic centre would be a hole in a non-bonding orbital on an oxygen. It thus seems most probable that the observed centres are NO_2 molecules, which in the gaseous state[5] give a hyperfine structure with $A \sim 44 \times 10^{-4}$ cm.$^{-1}$; this is not much smaller than that found in our experiments. (The possibility that our spectra arise from pockets of paramagnetic gases, such as nitric oxide, nitrogen dioxide or oxygen, is excluded by the fact that the spectra are anisotropic.)

Ard[6] has reported an isotropic nitrogen hyperfine structure of about the same separation as ours in sodium nitrate bombarded with X-rays, and he attributed it to NO_3 or NO_2 molecules. As remarked above, NO_3 molecules would not be expected to give a hyperfine structure, and it had earlier been shown by microchemical analysis (Hennig, Lees and Matheson[7]) that the gas trapped in heavily irradiated sodium nitrate consists of 98·5 per cent oxygen and 1·5 per cent nitrogen, with no significant amount of nitric oxide or nitrogen dioxide. We have found a rather complicated spectrum but with no trace of a nitrogen hyperfine structure in a single crystal of sodium nitrate; this had been subjected to the same dose of gamma-rays as the lanthanum magnesium nitrate where about 10^{17} centres were formed.

In the crystal containing americium, the intensity of the spectrum indicated that the crystal contained about 2×10^{15} centres immediately after growth; this number was roughly doubled some three months later (the crystal being kept at room temperature), but there was no appreciable increase in the following eighteen months. Other lines due to radiation damage grew in this period within the nitrogen hyperfine structure and prevented observation of any lines due to nitrogen-15 (natural abundance 0·4 per cent); these lines have not been interpreted. Each hyperfine line of nitrogen-14 is flanked by two satellites the behaviour of which is similar to those observed by Zeldes and Livingstone[8] and may be due to simultaneous flipping of a nearby proton spin. The intensity of the nitrogen lines in the crystal containing promethium, six months after growth, corresponded only to some 5×10^{15} centres; again there had been no appreciable increase in intensity after about three months. Measurements with a crystal containing about 10^{-7} gm. of curium-242 (a 6-MeV. alpha-particle emitter of half-life 160 days) showed a similar damage spectrum with nitrogen hyperfine structure (this obscured any spectrum due to Cm^{3+}, which is expected to be in a $5f^7$, $^8S_{7/2}$ ground-state). As in the case of americium, this spectrum was present immediately after growth, but was much stronger than with americium. It seems that such centres are incorporated in the crystal during growth, probably because the parent solution must contain many free radicals formed by the strong alpha-particle bombardment. The relatively low intensity in the case of promethium shows that beta-particles are very much less effective in creating such magnetic centres. Even with energetic alpha-particles, however, the damage spectrum is different in different nitrates, and a nitrogen hyperfine structure is not necessarily observed. In [(U, Np, Pu)O_2], Rb$(NO_3)_3$, two sets of three magnetic centres with 120° symmetry about the crystal axis are found[9] giving very narrow lines, but with no trace of hyperfine structure.

No lines due to Am^{3+} could be detected at any temperature, and this supports the expectation that the ground-state of this ion is $5f^6$, $^7F_0$. In the case of Pm^{3+}, a resonance spectrum would only be expected of the type arising from a non-Kramers doublet[10] as in praseodymium, holmium or terbium; no such spectrum could be detected using the highest sensitivity at 20° K. This may be due to a very short spin-lattice relaxation time, or to the ground-

state being a singlet (extrapolation of the crystal field theory of Judd[9] indicates that either a singlet or a nearby doublet may be the ground-state).

Although this work was originally undertaken in order to investigate the paramagnetic resonance spectra, if any, of the ions Am^{3+} and Pm^{3+}, the results illustrate how paramagnetic resonance may be applied to the investigation of radiation damage. Such work is most fruitful when a hyperfine structure is observed, since this 'labels' the magnetic centre; the value of the nuclear spin identifies the nucleus to which the electron or hole is attached (as with aluminium in quartz[11]) and the size of the structure indicates for what fraction of the time the centre is attached to a given nucleus. Further work is planned with substances where the majority or all of the nuclei have non-zero spin.

We are indebted to Dr. L. E. Orgel for helpful discussions; to Mr. G. R. Hall for preparation of the actinide crystals; to Dr. P. F. D. Shaw for the promethium crystal; and to Mr. W. A. Runciman for the gamma-irradiated crystal. One of us (W. H.) wishes to thank the Commissioners for the Exhibition of 1851 for the award of an overseas scholarship.

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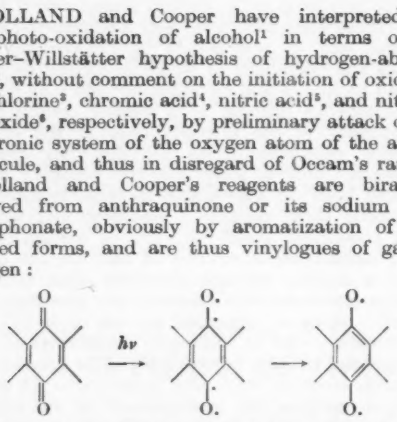
OXIDATION OF ALCOHOL

By Prof. J. KENNER, F.R.S.

Bolland and Cooper have interpreted the photo-oxidation of alcohol[1] in terms of the Haber–Willstätter hypothesis of hydrogen-abstraction[2], without comment on the initiation of oxidation by chlorine[3], chromic acid[4], nitric acid[5], and nitrogen tetroxide[6], respectively, by preliminary attack on the electronic system of the oxygen atom of the alcohol molecule, and thus in disregard of Occam's razor.

Bolland and Cooper's reagents are biradicals derived from anthraquinone or its sodium 2 : 6-disulphonate, obviously by aromatization of their excited forms, and are thus vinylogues of gaseous oxygen:



The electron transference from oxide ions to gaseous oxygen (Brin equilibrium), together with the facile attack by oxygen of ethoxide ion and the slower one of EtOH—OH_2 in aqueous alcohol[7], thus affords strong presumptive evidence of similar initiation of the photochemical oxidation.

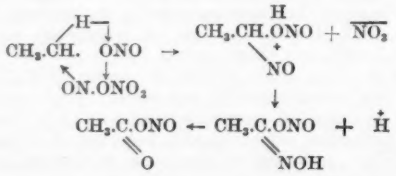
Again, the occurrence of formaldehyde or its oxidation products as subordinate products of the oxidation of alcohol by a variety of reagents[8], as well as photochemically (Cooper, private communication), and the production of methane in small amount from the anodic oxidation of ethoxide ion[9], indicate the formation in each case of some ethoxy radical[10]. Similarly, the 39 per cent yield of propane and propene together with carbon monoxide from the action of acetyl peroxide on *n*-butyl alcohol at 98° C. indicates initial formation of *n*-butoxy radical:

$$n\text{—}C_3H_7.CH_2OH + (CH_3.COO)_2 \rightarrow n\text{—}C_3H_7.CH_2O. + CH_3.COO. + CH_3CO_2H$$

and the production of methane by similar treatment of *iso*propanol[11] is thus attributable to attack on *iso*propoxy radical by acetoxy radical rather than to initial hydrogen-abstraction:

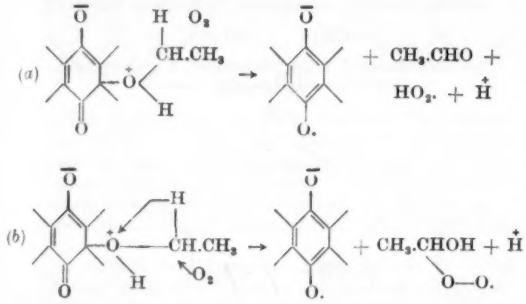
$$Me_2CHO. + CH_3COO. \rightarrow Me_2CO + CH_4 + CO_2$$

Further, the photochemical direct oxidation of alcohol to acetic acid, of which indications were secured by Bäckström[12], and which was confirmed by Bolland and Cooper[1], does not require the preliminary formation of Haber and Willstätter's[2] $CH_3.\dot{C}HOH$, for the acid is also produced by the action of nitrogen tetroxide[13], with ethyl nitrite as intermediate[6]. Isolation of $CH_3.COONO$ as a subsequent product, coupled with the indication, from the accelerative influence of moisture[14], that hydrogen is not removed as such but as proton[15], suggests that the second stage of the reaction, like the first, depends on attack by the peroxide at the original alcoholic oxygen atom. The electron-deficiency thus set up on the oxygen atom can be met by a Wagner–Meerwein type of change involving migration of a hydrogen atom (such as occurs in the formation of propene by electrolysis of potassium glutarate[16]) and its replacement by nitroso radical:



On this basis, resonance and steric factors require occurrence of the photochemical reaction by approach of the alcohol from above the plane of the ring and formation of a transient complex (I), precisely as in the case of unexcited quinones[17]; but the planarity of the biradical inhibits transition of the complex (I) to a fully covalent condition. It may then dissociate, yielding either the original reactants or an ethoxy

radical and a semiquinone. The presence of oxygen, however, much facilitates decomposition by Hofmann and Wagner–Meerwein types of reaction :



Of the two, (*b*) corresponds to that formulated in the case of ethyl nitrite, and later leads to the peroxy-compound, $CH_3.CH(OH).OOH$, postulated by Wieland[16] as precedent to acetic acid. The reaction depends on maintenance of the oxonium condition, whereas in (*a*) the primary step is removal of proton, which is assisted by presence of water as recipient in addition to semiquinone anion. Accordingly, Bolland and Cooper observed such conditions to assist acetaldehyde formation. Again, no acetic acid is formed if the solution is even faintly alkaline at the outset (Cooper, private communication) for, as each hydroxyl ion is destroyed by proton, a semiquinone anion is produced and can also serve to inhibit the oxonium condition.

In the case of *t*-butanol, the possibility of reaction is limited to dissociation of the initial complex into semiquinone and *t*-butoxy radical. The relative difficulty of this is evident from the stability of *t*-butyl hypochlorite (relative to those of its ethyl and *iso*propyl congeners)[3], for in this case also decomposition is recognized to proceed by dissociation —into radical and atomic chlorine[19]. Similarly *t*-butyl hydroperoxide is relatively stable[20]. Thus Bolland and Cooper's observation[1] of the slow photochemical oxidation of *t*-butanol affords no basis for the derogation, attempted by Wells[21], of the electron-transference mechanism ; correspondingly, the assertion that the photo-oxidation of cellulose proceeds by hydrogen-abstraction[22] is unjustified. It is intended elsewhere to extend this criticism to all applications of the Haber–Willstätter hypothesis.

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A NEW COMPOUND* ACTIVE AGAINST *TRYPANOSOMA CONGOLENSE* AND *T. VIVAX*

By W. C. AUSTIN, Dr. H. O. J. COLLIER, M. D. POTTER†, G. K. A. SMITH and Dr. E. P. TAYLOR

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SEVERAL authors have observed that certain compounds active against trypanosomiasis possess symmetrical molecules with relatively large end-groups, a structure which Goble[1] has called "butterfly" and Walls[2] "dumb-bell-shaped". Since decamethylene *bis* (*iso*-quinolinium bromide), prepared in these laboratories as a curarizing agent[3], possessed such a structure and since it exhibited considerable antibacterial activity *in vitro*[4], its possible therapeutic action against trypanosomiasis was examined in mice infected with *Trypanosoma congolense*. In this test, decamethylene *bis* (*iso*-quinolinium bromide) significantly prolonged the lives of infected animals, and accordingly, a series of polymethylene homologues was examined and found to possess slight activity against *T. congolense*, which seemed highest in the hexamethylene member.

As the decamethylene chain was most readily available, we next decided to prepare a number of heterocyclic decamethylene *bis* (quaternary ammonium salts) for test against trypanosome infections of mice with the intention of later varying the chain-length of the more promising compounds. Since several synthetic trypanocides are derivatives of 4-aminoquinaldine[5], decamethylene *bis*(4-aminoquinaldinium iodide) was one of the earliest compounds made.

This showed appreciable activity, and in near-lethal doses was able to cure mice infected with *T. rhodesiense*, or, when administered several days before infection, to protect them. This compound also showed high antibacterial and antifungal activity and is now available under the name 'Dequadin'[6].

Reducing the chain-length in the *bis*-4-aminoquinaldinium series produced compounds of greater activity against trypanosome infections of mice. The product of the reaction between 4-aminoquinal-

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dine and hexamethylene di-iodide, on recrystallization from ethanol–ether mixture, analysed satisfactorily for the anticipated hexamethylene *bis*(4-aminoquinaldinium iodide) and showed particularly good activity against *T. congolense*.

This material was therefore prepared on a larger scale, and the product, when recrystallized from ethanol, had a slightly higher melting point. It showed, however, quite unexpectedly low potency, which proved to be less than that of the crude product before recrystallization, indicating that activity might be attributed to an impurity. Fractional crystallization of the crude reaction mixture, while not achieving complete separation, yielded three different fractions which possessed different pharmacological activities (Table 1).

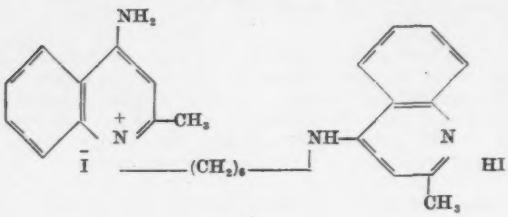
Table 1. Distinction of Three Substances in Fractions obtained from Recrystallization of the Product of Interaction of Hexamethylene di-iodide and 4-Aminoquinaldine

Fraction	Activity against *Trypanosoma congolense*	Activity against *Trypanosoma rhodesiense*	Toxicity to mice
I	low	moderate to high	high
II	high	moderate	low
III	low	low	low

Since Fraction II showed the highest activity against *T. congolense* and had low toxicity, it was considered to contain the active impurity, which we provisionally called 'Substance II'.

Paper chromatographic investigation of the crude reaction mixture (using ethanol–butanol–water as the mobile phase) confirmed that three distinct products were formed when the reaction was carried out in solution in methyl *iso*butyl carbinol. When, however, the reaction solvent was ethyl methyl ketone, an additional fourth (pharmacologically inactive) product was obtained.

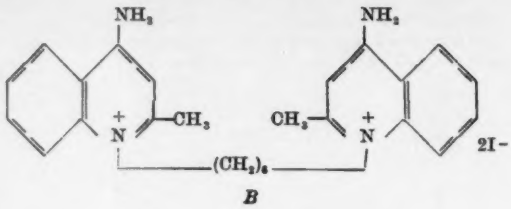
By very laborious fractional crystallization the active 'Substance II' was eventually isolated in the pure state in very poor yield. Analysis showed it to be isomeric with hexamethylene *bis*(4-aminoquinaldinium iodide), which explained the satisfactory analysis found for the first batch. Although several structures of 'Substance II' were theoretically possible, unambiguous synthesis finally established it to be the hydriodide of 6′(4-quinaldylamino)hexyl-4-aminoquinaldinium iodide (formula *A*):



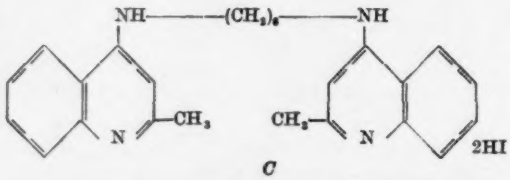
A

This unsymmetrical structure is of particular interest, since a symmetrical one had originally been sought. Both the symmetrical isomers *B* and *C* of 'Substance II' were less active against *T. congolense*, although the *bis*-quaternary salt *B* was slightly more active against *T. rhodesiense* than was 'Substance II'.

These findings seem to suggest that while compounds with symmetrical forms are often active against *T. rhodesiense* (cf. also suramin, the diamidines, etc.), compounds exhibiting the highest



B



C

activity against *T. congolense* are unsymmetrical (cf. also the phenanthridiniums, antrycide, etc.).

Administered subcutaneously to mice, 'Substance II' was more active than antrycide against infections of *T. congolense* and *T. vivax*, and less toxic (Table 2).

Table 2. Curative Action against Trypanosome Infections and Toxicity of 'Substance II' and Antrycide

Drugs were administered subcutaneously to mice and the 50 per cent curative (*CD*50) and 50 per cent lethal (*LD*50) doses are expressed as mgm. cation/kgm. body-weight

Drug	*CD*50 *T. congolense*	*CD*50 *T. vivax*	*LD*50 mice
'Substance II'	0·42 ± 0·05	0·68 ± 0·09	153·89 ± 22·47
Antrycide	0·73 ± 0·08	1·80 ± 0·28	19·53 ± 0·82

Several salts of 'Substance II' have been prepared, and solutions of its chloride show appreciable prophylactic activity against *T. congolense* in mice. The duration of effective prophylaxis was more than doubled, however, by administration of a suspension formed by mixing 'Substance II' chloride with suramin, although the latter drug itself showed no prophylactic activity against *T. congolense*. This finding was in agreement with those of Williamson and Desowitz[7] in respect of the prophylactic activities of suramin complexes of ethidium and antrycide. The very sparingly soluble salt of suramin and 'Substance II' is at present under investigation and has shown extremely low toxicity to mice.

It is noteworthy that the decamethylene *bis* (*iso*-quinolinium) series from which this investigation sprang also possess high antifungal activity[8] and its further chemotherapeutic potentialities are under investigation.

Full chemical and pharmacological details of this work will be published elsewhere. We are indebted to the directors of Messrs. Allen and Hanburys, Ltd., for permission to publish this work and to Mr. J. J. Grimshaw for statistical analysis.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Avogadro's Number and Loschmidt's Number

In his Rutherford Memorial Lecture[1] Sir Charles Darwin writes: "The first estimate of Avogadro's number is due to Maxwell himself", and expresses his astonishment that Maxwell "should have published a fact of such tremendous importance in a manner that cannot have drawn much attention to it".

The reason for Maxwell's choice seems to have been that he did not claim to communicate anything fundamentally new, but only to discuss a line of reasoning which Loschmidt had published eight years earlier in the *Proceedings* of the Vienna Academy[2]. Using Maxwell's own words[3], he "followed the track of Prof. Loschmidt", who had been the discoverer of the "fact of tremendous importance"; in his paper, Loschmidt stated explicitly only the radius of the molecules, but as his argument included the assumption that in the liquid state the molecules practically touch each other, the number of atoms in 1 c.c. of a gas can instantly be inferred from his result. To quote from Maxwell's lecture delivered before the British Association at Bradford[4]: "Loschmidt, in 1865, made the first estimate of the diameter of a molecule. . . . According to the Table, which I have calculated from Loschmidt's data the size of the molecules of hydrogen is such that about two millions of them in a row would occupy a millimetre. . . . In a cubic centimetre of any gas at standard pressure and temperature there are about nineteen million million million molecules".

It is somewhat surprising that Loschmidt's brilliant achievement has been overlooked so frequently, in spite of Maxwell's full acknowledgment. Whoever wants the opinion of another most competent judge on the importance of Loschmidt's contribution may read Boltzmann's memorial lecture on Loschmidt[5], which will dispel any possible doubt as to the real discoverer of this fundamental constant. To call it Avogadro's number is justified only in a restricted sense, as Avogadro did not even know the order of magnitude of this figure approximately; he died nine years before Loschmidt's paper appeared. In Germany, Austria and Switzerland, some physicists speak of 'Loschmidt's number', if the number of molecules per c.c. is quoted, and of 'Avogadro's number', if it is related to a mole; this practice rather obscures the fact that in both cases one and the same constant is expressed in but slightly different ways, but it may be a useful distinction and does justice to Avogadro's basic idea. Maxwell, however, would never have claimed any share in the discovery of Loschmidt's (or Avogadro's) number.

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Nov. 2.

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I must plead guilty to the charge of not having made a very deep search of the older literature in connexion with the evaluation of 'Avogadro's Number'. This name has only come into general use in rather recent years; for example, in the first edition of Kaye and Laby's Tables (1911) the constant N_m is given no name at all. However, I am afraid that the use of Avogadro's name in this connexion led me to overlook Loschmidt's work, so that I was content to find and verify a short reference to Maxwell. I am grateful to Prof. Paneth for putting this matter right.

C. G. Darwin

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Type of Ion Migration in a Metal/Metal Oxide System

One of the essential factors in the study of the formation of oxide films is to determine experimentally which of the ions, the metal cation or the oxygen anion, moves the faster during thermal or anodic oxidation of the metal.

Ion migration in several metal/metal oxide systems has been studied by the marker technique introduced by Pfeil[1]. This method, in which an inert marker is covered by the oxide if the metal ion moves outwards, or alternatively which remains free on the oxide surface if the oxygen ion moves inwards through the oxide, is most suitable when the degree of oxidation is considerable, as, for example, at high temperatures.

In this communication a technique to determine the nature of the ion migration under a relatively small electric field at room temperature is outlined. The first metal chosen for study was zirconium, and it is this experiment, together with its interpretation, which will now be described.

Two electrodes of zirconium metal with, of course, a thin oxide layer on their surfaces, were separated by a sintered compact of zirconia. Between the upper and lower surfaces of the zirconia compact and the corresponding electrode surfaces were placed pieces of Whatman No. 31 (electrophoresis grade) filter paper. These filter papers were previously prepared as a colour detector for zirconium ions by soaking in a solution of alizarin-*S* dissolved in alcohol followed by drying at 125° C.

The following chemical experiments were performed on the reagents.

(*a*) It was established that in the presence of nascent oxygen from hydrogen peroxide the alizarin-*S* reagent turned yellow.

(*b*) In the presence of zirconium ions the typical red colour given by the alizarin-*S* is retained in the presence of nascent oxygen from hydrogen peroxide.

The assembly described above was placed in a tube at room temperature through which dry nitrogen gas was flowing. After the tube had been well flushed of air and contained dry nitrogen gas only (free from oxygen) a d.c. voltage of the order of 1,000 V./cm. was applied for several hours.

Examination of the filter papers after dismantling revealed the following:

(1) The filter paper in contact with the positive electrode had changed from the orange-pink colour of the original condition to a yellow colour in that region where contact was established. In the

middle of these yellow regions zirconium oxide appeared to have formed.

(2) The underside of the filter paper in contact with the negative electrode was coloured mauve-red, the typical colour given by solutions of zirconium salts with this reagent.

(3) There was some corrosion of the metal surfaces, with what appeared to be oxide formation on the positive surface.

In the light of these facts, the following tentative explanation is proposed suggesting that it is the anions (oxygen ions) which move in zirconium under the action of an applied field at room temperature.

Oxygen ions migrate from the negative electrode towards the positive electrode. Dependent upon the relative efficiencies between yielding oxygen gas at the positive electrode (anode) and adsorption of the oxygen as ions for film growth on the anode, some of the oxygen ions will give up their electrons and become nascent oxygen reacting with the alizarin-*S* to give a yellow colour.

It seems plausible that the sintered oxide compact contains a non-stoichiometric excess of oxygen which will account for both processes occurring at the anode.

At the negative electrode (the cathode) a deficiency of oxygen ions is created by their migration into the compact. The cathodic zirconium surface is thus enriched in zirconium ions which are absorbed by the alizarin-*S* to give the typical red colour.

It has been established that these reactions do not occur in the absence of an electric field.

Preliminary results have been obtained on other materials, and further experiments are in progress to establish the mechanism with greater certainty. At high fields it is possible that the zirconium ions will move faster than the oxygen ions in zirconia, due to the higher charge on the zirconium ions. It is hoped to report these results in the near future.

We wish to acknowledge the helpful interest shown by Dr. H. M. Finniston and Dr. P. J. Anderson in this work.

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An Infra-red Photocell based on the Photoelectromagnetic Effect in Indium Antimonide

The photoelectromagnetic effect has been studied in germanium[1], silicon[2] and lead sulphide[3] as a means of measuring life-time and velocity of surface recombination. In indium antimonide the effect can be applied not only for this purpose[4], but it can also provide the basis for a useful photocell. The arrangement for this is illustrated in Fig. 1. The sensitive element consists of a rectangular slice (*A*) of pure single-crystal material of dimensions 2 mm. × 1 mm. and approximately 0·1 mm. thickness, with a pair of electrodes (*B*) connected to the top and bottom faces. The element is immersed in a magnetic field of about 10,000 gauss provided by the ring magnet (*C*). Radiation of suitable wave-length falling on the front face of the element generates hole-electron pairs near the surface; these diffuse inwards, and in so doing become separated vertically by the magnetic field, giving rise to an e.m.f. between the electrodes. If the radiation is chopped by a rotating toothed disk, in the usual way, an interrupted output is obtained, which can be fed to a conventional a.c. amplifier through a matching transformer.

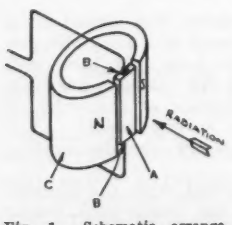

Fig. 1. Schematic arrangement of photoelectromagnetic cell

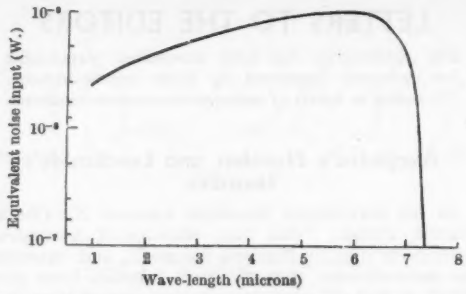

Fig. 2. Spectral sensitivity of indium antimonide photoelectromagnetic cell

The spectral sensitivity of a typical cell of this type is plotted in Fig. 2, showing at each wave-length the energy required to give a signal-power equal to the average noise-power in a frequency interval of 1 c./s. centred at the chopping frequency. The response shown was measured at room temperature; a considerable increase in signal/noise ratio is obtained by cooling, but this has not yet been studied quantitatively.

The variation of response as a function of chopping frequency (not illustrated) shows that the time constant of the cell is of the order of 1 μsec. or less, which is consistent with the known short life-time of excess carriers in indium antimonide[4].

Acknowledgment is made to the Admiralty for permission to publish this communication.

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Nov. 1.

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The Benzotrifluoride–Nitryl Fluoride–Boron Trifluoride Complex

In two earlier communications[1] we have reported the isolation of the stable hydrogen fluoride–, deuterium fluoride–, alkyl fluoride– and formyl fluoride–boron trifluoride complexes of the methylbenzenes. We have tried now by the same methods to investigate the complex formation during the reaction of nitryl fluoride with aromatics, catalysed by boron trifluoride.

The nitryl fluoride, as the acid fluoride of nitric acid, reacts in the same fashion in Friedel–Crafts

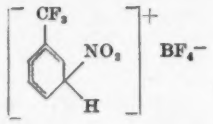
acylating reactions (for example, in this case in the nitration) as the fatty acid fluorides. In earlier work it was possible to use the nitryl fluoride–boron trifluoride system as the isolated stable nitronium borofluoride complex to work out a new nitration reaction[2].

As a consequence of the great reactivity of nitryl fluoride, in this case the preparative difficulties are much greater than in the acylating reactions of the fatty acid fluorides catalysed by boron trifluoride[3]. Moreover, the nitryl fluoride is also a strong oxidizing agent and even a fluorinating agent. The use of methylbenzenes is not to be recommended in the nitrating reaction catalysed by boron trifluoride because of the reaction velocity of the activated aromatic nucleus, which is so great that the reaction takes place even at − 100° with explosion.

We have found that benzotrifluoride is a suitable model for our experiments. The melting point is relatively low, − 29°, the CF_3 group shows a strong $-I$ effect and de-activates the nucleus, and in consequence the reaction with nitryl fluoride is moderated; at temperatures less than − 20° no reaction is observed. Nitronium borofluoride itself nitrates benzotrifluoride only at + 100°.

We have prepared the nitryl fluoride needed for our experiments according to the method of Schmeisser and Elischer[4] with the thermal decomposition of nitronium borofluoride with sodium fluoride.

We added 14·5 gm. (0·1 mole) benzotrifluoride carefully in small portions to 6·5 gm. (0·1 mole) nitryl fluoride at − 80°. No reaction was observed; then we added 0·2 mole boron trifluoride to the system at − 120°. After homogenizing, the reaction mixture was allowed to warm slowly up to − 100°, during which the excess of boron trifluoride distilled off. 0·1 mole boron trifluoride was held back in the reaction mixture, showing that a 1 : 1 : 1 nitryl fluoride : benzotrifluoride : boron trifluoride complex was formed. The yellow solid complex was stable up to − 50°, when it decomposed without melting with strong evolution of boron trifluoride and with a nearly quantitative yield of *m*-nitro benzotrifluoride. Although in this case the complex has no sharp decomposition point and the specific conductivity could also not be determined, still we think that, according to the analogy of the earlier work, in which the stable intermediate complexes of aromatic substitutions were investigated[1], in this case also the 1 : 1 : 1 molecular complex can be formulated as an onium salt (or σ-complex) with the following structure:



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Blood Group P Substance in Hydatid Cyst Fluids

In the past eight years, 132 cases of hydatid disease have been treated in the Auckland Group of Hospitals. Among these patients, two were found to have strong anti-P agglutinins in their sera. These were recognized in the course of cross-matching blood for transfusion. About ninety of these cases had blood cross-matched, and of these only 25 per cent could be expected to be P-negative and able to have anti-P agglutinins in their sera. It seemed that this was a selected group presenting a high proportion of unusually strong anti-P sera. Merritt and Hardy[1] reported a serum containing strong anti-P in a boy aged twelve years with hydatid disease.

The association of hydatid infestation with strong anti-P led us to examine some hydatid cyst fluids for anti-P inhibiting substances which may have been responsible for the stimulation of anti-P agglutinins in these cases. The method used was that described by Race and Sanger[2] for testing for A and B substances in saliva, but substituting a strong anti-P serum and strongly reacting P-positive red cells for the anti-A and anti-B sera and A and B cells.

The dilutions of the cyst fluids in saline were carried to at least 1 in 128. The hydatid cyst fluids were obtained from cysts in the livers of sheep, and in each cyst the presence or absence of live scolices was noted. The results are shown in Table 1.

It will be seen that there is no inhibition of anti-P where scolices are absent, and considerable variation in the concentration of the inhibiting substances where live scolices are present. It is probable that the presence of specific inhibiting substances is dependent upon an active germinal layer of the cyst wall. No diminution of anti-P inhibition was observed after boiling the cyst fluids in a water-bath for 10 min., centrifuging, and using the clear supernatant fluid in the tests. Further, it was found that no inhibition of the specific activity of the various other blood-group antisera available resulted when these were incubated with an equal volume of undiluted fluid obtained by pooling the fluids of nine cysts. The antisera tested were anti-A, -B, -M, -N, -S, -Le^a, -H, -Lu^a, -D, -C, -C^w, -c, -E, -Kell, -Fy^a. The temperature used for the absorption and the

Table 1

Cyst fluid No.	Maximum dilution of hydatid fluid showing complete inhibition of anti-P	Absence, presence and condition of hydatid scolices
1	32	Active scolices
2	64	Active scolices
3	No inhibition	No scolices
4	128	Active scolices
5	64	Active scolices
6	32	Active scolices
7	256	Active scolices
8	64	Active scolices
9	32	Active scolices
10	No inhibition	No scolices
11	No inhibition	No scolices
12	4	Few degenerate scolices
13	No inhibition	Few degenerate scolices
14	32	Active scolices
15	16	Few active scolices
16	No inhibition	Degenerate scolices
17	No inhibition	Degenerate scolices
18	64	Active scolices
19	32	Active scolices
20	128	Active scolices
21	128	Active scolices
22	128	Active scolices
23	128	Active scolices
24	128	Active scolices
25	128	Active scolices

method for testing the absorbed serum with appropriate red cells were those suitable to the individual antiserum.

The possibility of producing potent anti-P testing sera by immunizing rabbits with selected hydatid cyst fluids is being investigated.

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Hæmoglobin in the Crustacea

Hæmoglobin in solution in the blood plasma is found in numerous entomostracan Crustacea. Ray Lankester first discovered it in *Chirocephalus*, observing the absorption bands of oxyhæmoglobin with a microspectroscope[1], and soon afterwards found it in *Daphnia*. The wave-length of the α-band differs among species within the genus *Daphnia*[2]. The pigment also occurs in the blood of other Cladocera, for example: *Sida*, *Simocephalus*, *Moina*, *Bosmina*, *Ilyocryptus*, *Eurycercus*, *Leydigia*, *Chydorus*, etc., but not in *Leptodora*. The hæmoglobin of *Ceriodaphnia* has a higher oxygen affinity than that of *Daphnia*, and the former lives in fouler water[3]. Hæmoglobin is present, too, in Phyllopoda: it is in the blood of Conchostraca (*Lynceus*, *Leptestheria*[4], *Limnadia*), Anostraca (*Chirocephalus*, *Artemia*[5,6]) and Notostraca (*Triops*[7], *Lepidurus*). It may be universal in the blood of the Phyllopoda. Among the Ostracoda, hæmoglobin occurs in *Cypria*[8] and *Pseudocypris*.

In the Copepoda, the parasites *Lernaeocera*[2,9] and *Mytilicola*[10] have hæmoglobin in the blood, but hitherto the pigment has been unknown in free-living forms. I have not detected it in *Diaptomus* or *Cyclops*; but lately have found it in the blood of various species of Harpacticoidea. The blood of these animals does not circulate, as there is no heart. Hæmoglobin was first detected in a new marine species, *Laophonte foxi* Harding[11], living in mud; but none could be found in the common species *Tisbe furcata* (Baird), moving freely in sea water. Hæmoglobin is present in the blood of the common freshwater species *Canthocamptus staphylinus* Jurine, found on and in mud, but it is absent from *Bryocamptus pygmaeus* (Sars), on wet moss. *Attheyella crassa* (Sars) from the bottom of the Lago Maggiore at a depth of 120 m. and from moss in a rivulet at Pallanza in Italy had hæmoglobin, but the concentration was considerably greater in the former situation. A full account of this investigation will be published elsewhere.

Among the Cirripedia, hæmoglobin is unknown in the barnacles, although it is present in the blood of some of the parasitic Rhizocephala: among these there is none in *Sacculina*, but it occurs in *Septosaccus*[12] and *Peltogaster*[13]. Not only is hæmoglobin thus found in the blood of numerous Crustacea, but it also occurs in a variety of tissues in *Daphnia*, namely, muscle, nervous system, fat cells[14] and eggs. This is in contrast to the Vertebrata, where the pigment is only present in red blood cells and in muscle. In the Cladocera and Phyllopoda the concentration of hæmoglobin in blood and tissues varies inversely as the dissolved oxygen concentration in the water, the changes being both rapid and considerable when animals pass from one water to another[15].

Hæmoglobin, we have seen, is present in Branchiopoda, Ostracoda, Copepoda and Cirripodia, yet it is not known to occur in the higher Crustacea, the Malacostraca. In two malacostracan groups, the Decapoda and Stomatopoda[16], the copper-containing respiratory protein hæmocyanin, blue in the oxidized state, occurs dissolved in the blood plasma. Hæmoglobin has indeed been reported in a species of the Amphipoda, *Urothoe grimaldii* Chevreux[17], which burrows in sand on the sea-shore. I have, however, been unable to confirm this report, finding no hæmoglobin in animals of this species from near Plymouth: 30 individuals were examined spectroscopically on three different occasions.

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Dec. 10.

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Presence of a Substance Rich in Protein-bound Cystine or Cysteine in the Neurosecretory System of an Insect

Comparisons have been drawn between the hypothalamo-hypophysial neurosecretory system of vertebrates and corresponding systems in invertebrates; for example, the pars intercerebralis-corpus cardiacum neurosecretory system of insects[1]. Such comparisons are supported by the demonstration in both groups[2] of a deeply staining chrome–alum–hæmatoxyphil neurosecretory material. In the dog, this material has been described as a glycolipoprotein 'bearer-substance', soluble in lipid-solvents, and for this reason clearly to be differentiated from the posterior pituitary principles[3]. There is, however, an alternative view[4], namely, that chrome–alum–hæmatoxyphil vertebrate neurosecretory material, or material in its exact distribution, is essentially a protein, which, in tissues which have not been fixed in formalin, is soluble in water rather than lipid solvents, and which for these reasons, and because of its high cystine content, could well be closely akin to the posterior pituitary principles. The present investigation is concerned with the nature of neurosecretory material in the intercerebralis–cardiacum system of the cockroach, *Leucophaea maderae*.

Prof. Berta Scharrer very kindly provided me with tissues from five adult cockroaches, fixed in Helly's fluid (formol-Zenker), embedded in paraffin wax, and serially sectioned. Representative sections, stained

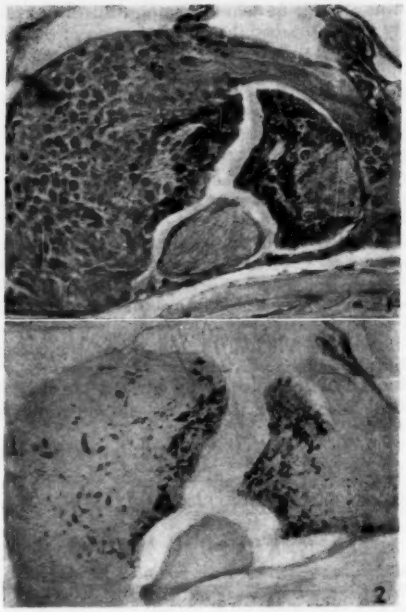

Fig. 1. Cross-section of corpus cardiacum in *Leucophaea maderae*, to show normal distribution of deeply staining chrome-alum-hæmatoxyphil neurosecretory material. Chrome-alum-hæmatoxylin technique. × 200

Fig. 2. Adjacent section to Fig. 1, to show cystine-rich material in same distribution as that revealed by chrome-alum-hæmatoxylin technique. Performic acid Alcian blue technique. × 200

by the chrome–alum–hæmatoxylin technique, revealed deeply staining dark-blue material throughout the neurosecretory system, the largest accumulation lying in the corpus cardiacum (Fig. 1). Adjacent sections were submitted to histochemical techniques capable of demonstrating cystine. The first, the performic acid Alcian blue reaction[5], selectively stained material throughout the entire distribution of the chrome–alum–hæmatoxyphil neurosecretory substance (Fig. 2). This reaction is given by sulphonates derived from protein-bound cystine or cysteine. In control sections in which oxidation by performic acid was omitted, no comparable staining by Alcian blue was obtained. The reacting material persisted in deparaffinized sections both after lipid-extraction in hot chloroform–methanol, and digestion by Armour's crystalline trypsin (0·1 and 1 mgm. per ml. of Sörensen buffer at *p*H 7·2 at 37° C. for 30 min.), in the latter respect alone differing from neurosecretory material in the posterior pituitary of the dog. Evidence for the presence of cystine, as opposed to cysteine, in the corpus cardiacum (after fixation) was obtained by the application of Adams's thioglycollate–ferric ferricyanide technique, with the appropriate controls[6].

Cystine and cysteine are widely distributed constituents of vertebrate tissues, so that their histochemical localization in a given site suggests, on one hand, the relative insensitivity of the technique used, and on the other, the presence of a high local concentration of these amino-acids. If the same may be said of invertebrate tissues, then it may be inferred that the intercerebralis–cardiacum neurosecretory system of *Leucophaea maderae* contains material rich in protein-bound cystine and cysteine. Personal studies with the performic acid Alcian blue technique have shown this to be true of preoptico-hypophysial and supraoptico-hypophysial neurosecretory material in a wide variety of vertebrates. On the basis of such observations, it is tempting to speculate that a group of neurosecretory proteins exists which is rich in protein-bound cystine or cysteine and is common to vertebrates and invertebrates alike. This speculation is the more plausible in view of the comparisons[1] which have already been made between neurosecretory systems in the two groups. It is the more interesting because certain mammalian posterior pituitary principles have already been shown to be exceptionally rich in cystine[6].

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Correlation between Luminescence and *L*-Bodies in a Strain of *Photobacterium fischeri*

When studying the morphology of a strain of *Photobacterium fischeri*, originally isolated from the surface of a luminous Baltic herring, we observed a surprisingly large number of *L*-bodies similar to those described by Johnson *et al.*[1]. As the number of these *L*-bodies seemed to be related to the luminous intensity of the colonies a detailed study was considered worth while.

The bacterium was grown on fish-broth agar containing: peptone, glycerol, 3 per cent sodium chloride and powdered calcium carbonate as a buffer. On this substrate the bacterium showed a bright green luminescence. Stock cultures were grown on agar slants at about 7° C. All microscope preparations were stained with carbol fuchsin. Possible artefacts produced by the staining were checked by phase-contrast microscopy.

As some authors[2,3] stress the significance of low temperatures for *L*-body formation, we started by studying the influence of different growth temperatures. Growth and luminescence were estimated visually on fish-agar slants. The percentage of *L*-bodies was determined by cell counts under the microscope (see Table 1).

It is seen that the luminescence and occurrence of *L*-bodies are closely related and have the same tem-

Table 1. Growth, Luminescence and Percentage of *L*-Bodies in 3-day Cultures of *P. fischeri*

Temperature	Growth	Luminescence	Percentage of *L*-bodies
0° C.	+	+++	45·4
7	++	++	34·7
14	++	(+)	1·5
22	+++	−	<0·01
27	++	−	0
37	−	−	0

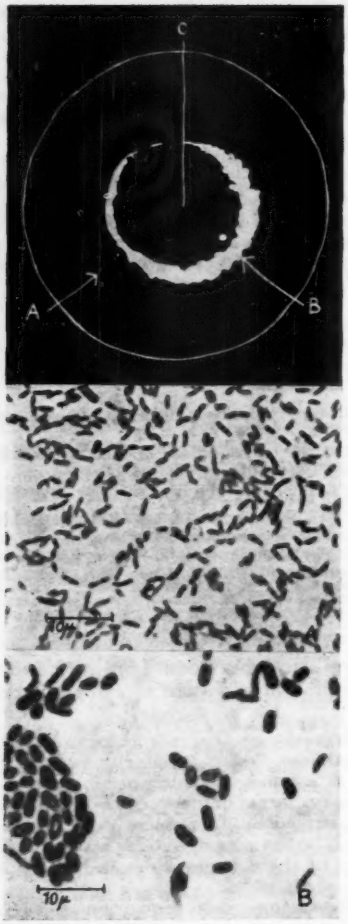

Fig. 1. Auxanogram of the formaldehyde test at 20° C.; the plate was photographed by its own light. (*A*) Non-luminous growth; (*B*) bright zone. *c*, The spot where formaldehyde was added

perature optimum, which is distinctly below that of growth. Further, we found that if a culture was grown at 0° C. and subcultured every second day, the percentage of *L*-bodies could be maintained at about 70.

Certain substances are known to induce formation of *L*-bodies in various bacteria[3,4]; accordingly, we tested a number by the auxanogram technique of Johnson[5] for their possible effect on luminescence or *L*-body formation. Fish-agar plates were inoculated with four-day luminescent cultures suspended in 3 per cent sodium chloride. A trace of the substance to be tested was placed in the centre of the inoculated plate. The plates were then incubated at 5° C. for three days.

Among the chemicals tested, cupric chloride, caffeine, acetone and dimethyl-*p*-aminobenzaldehyde had a weak stimulating effect on both light-production and *L*-body formation. The most striking effect was obtained with formaldehyde. At the edge of the zone of inhibition, there was a narrow zone of extremely bright luminescence surrounded by unaffected growth with normal luminescence. When formaldehyde was tested at 20° C., at which temperature luminescence usually is not produced, the same type of bright zone with increased number of *L*-bodies was formed, without the fainter 'background' luminescence. This test is shown in Fig. 1. The growth in the bright zone is seen to consist almost entirely of *L*-bodies (Fig. 1*B*), while there are practically no such bodies among the non-luminous growth (Fig. 1*A*).

Luminescence and *L*-body formation were never stimulated independently of each other by the substances tested. We also noted that the stimulating effect of formaldehyde was greatly reduced if the concentration of sodium chloride was lowered. Neither luminescence nor *L*-bodies were ever noted in the total absence of sodium chloride (cf. ref. 6).

As a general rule, we found that in connexion with any noticeable change in luminescence, caused by different growth conditions, a corresponding change in number of *L*-bodies could always be observed.

A full account of this work will be published in due course.

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Fate of Spermatozoa not participating in the Fertilization Process

Concerning the fate of, and the possible effects exerted by, spermatozoa not participating in the process of fertilization in the female organism, Genin *et al.* have recently concluded that: (1) by active movement the spermatozoa of the most widely differing animal species are capable of penetrating the uterine wall and the diverse tissues; and that (2) the spermatozoa and the cells of the tissue which they penetrate act upon each other, the interaction manifesting itself cytologically in the breaking off or dissolution of the anterior part of the head of the spermatozoon.

Subjecting these conclusions to a critical study, we have failed to find confirmation for them. From the evidence of our experiments, the appearance of spermatozoa in the uterine tissues is due to an artefact arising during the preparation of cuttings for histological examination, and the alleged cytological manifestation of interaction is likewise the consequence of the technique applied in serial cutting. This leaves the problem of the relationship of uterine tissue cells and spermatozoa unsettled.

Significance seems to be attached to the acid-fast substance in the head of the spermatozoa. This substance, of mycolic acid type, which is imparted to the spermatozoa in the cells of Sertoli, permits the elective demonstration of sperm between the cells. Using it to study the distribution of human and rat spermatozoa introduced intravenously into rats, the spermatozoa were found to be taken up by the organs of the reticulo-endothelial system (lungs, liver, spleen, kidneys). This appears to confirm that cells of the phagocytic type are responsible for the disappearance of the spermatozoa, and that thus the

process is one of the functions of the reticulo-endothelial system.

A detailed report of this work will be published in the *Acta Morphologica Hungarica*.

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Effects of 8-Azaguanine on Sugar Beet infected with Beet Yellows Virus

Matthews has shown[1-3] that applying the guanine analogue 8-azaguanine (5-amino-7-hydroxy-1-V-triazolo (D) pyrimidine) to *Nicotiana* spp. infected with lucerne mosaic virus and to *N. tabacum* infected with tobacco mosaic virus delays the onset of symptoms. Over the past two years, we have made similar tests with 8-azaguanine on sugar beet (*Beta vulgaris*) infected by aphids with beet yellows virus, which, in some years, is the cause of large losses of crop yield in the United Kingdom and other countries. We have observed a delay in the appearance of symptoms of about the same magnitude as those observed with tobacco mosaic virus. Matthews[3] obtained delays in the appearance of symptoms with non-persistent viruses transmitted mechanically, but no such delays occurred when the same viruses were transmitted by aphids. Our results show that a delay can be obtained with a persistent, aphid-transmitted virus.

Using a virulent strain of the virus and three different types of sugar beet of known origin, essentially the same results were obtained in four separate experiments with plants grown in pots in the greenhouse. Seedlings were inoculated at the two-leaf stage by allowing five *Myzus persicae* (Sulz.) to feed on each plant immediately after feeding on heavily infected plants. Approximately half the plants were treated at three-day intervals with 15 ml. of 0·01 *M* 8-azaguanine dissolved in 0·1 per cent sodium bicarbonate solution. The greater part of this was watered on to the soil and a little sprayed on to the foliage. Small numbers of uninoculated plants were also treated with 8-azaguanine or with sodium bicarbonate only. Two applications of 8-azaguanine were made before inoculation, and there was no evidence that this prevented normal feeding by the aphids. This was confirmed later by the fact that only a very low proportion of the plants proved to be uninfected in any experiment.

Vein-etch symptoms, characteristic of plants infected with necrotic strains of virus yellows, were recorded. These first appeared seven days after inoculation, and afterwards plants were examined daily for symptoms. Symptoms appeared in the untreated plants on the average three to four days earlier than in the treated plants; the plants individually showed delays ranging from one to nine days. The results of one such experiment are set out in Fig. 1.

No stunting was apparent while the symptoms were appearing, but later there was considerable stunting and distortion in the treated plants. It is not certain, therefore, whether the delay in appearance of symptoms occurs because the yellows virus is affected directly, or because the growth of the plants is affected.

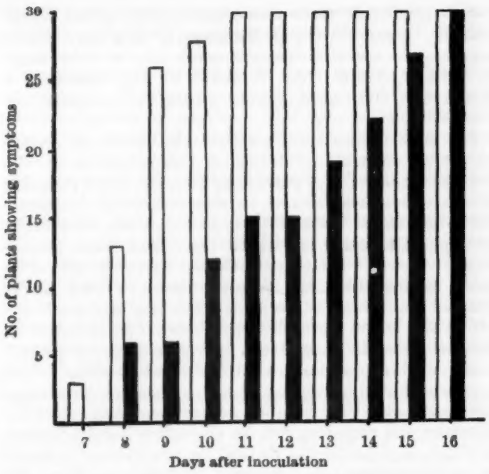

Fig. 1. Effect of 8-azaguanine on the time of appearance of beet yellows virus symptoms in sugar beet. Open columns, controls (30 plants); solid columns, plants treated with 8-azaguanine (30 plants)

The three beet types so far tested differ in field and glasshouse tolerance, as measured by severity of leaf symptoms and proportional loss of yield on infection. Their reaction to 8-azaguanine treatment after inoculation was very similar; there is, therefore, no indication from these experiments of a relationship between tolerance and delay in appearance of symptoms of infected plants treated with 8-azaguanine.

We are much indebted to Dr. R. E. F. Matthews for his interest, and for making it possible for us to obtain samples of 8-azaguanine through the generosity of the American Cyanamid Company.

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Reversal of Phototaxis in the Larvæ of *Polydora pulchra*, Carazzi (Polychæta, Spionidæ)

Reversal of phototaxis has been noted in a number of animals and attributed to fright, hunger and food and other chemical stimuli. The only case known to me in which the direction of phototaxis is determined by the salinity of the environment is provided by the larvæ of *Polydora pulchra*, Carazzi, previously recorded[1] from the plaice ponds at the Marine Biological Station, Port Erin. The larvæ, which ranged in size from 0·5 mm. to 1·5 mm., were all positively phototactic in solutions of salinity 32·6 per thousand and above, and all negatively phototactic in solutions of salinity 32·5 per thousand and below. Salinities below 30·0 per thousand were lethal within 24 hr. In any given salinity the larvæ maintained the same orientation indefinitely or until death, and the behaviour of specimens kept overnight at salinity 40·0 per thousand was afterwards

indistinguishable from those taken from pond water (salinity about 34·0 per thousand). For any given salinity, the reaction was the same over a wide range of light intensity from 3 watts to 100 watts at a distance of 200 cm. and over a range of temperature 0·0°–32·0° C.

In order to find out whether the operative factor was total osmotic pressure of the solution, or the concentration of any particular ion, the light reaction of the larvæ was noted in the following solutions. Each had as its basis 100 c.c. of sea water of salinity 32·5 per thousand (in which the larvæ were photonegative) and 1 gm. of a different salt was added to each, raising the total osmotic pressure well above that of sea water of salinity 32·6 per thousand (in which the larvæ were photopositive). The addition of sodium chloride caused the larvæ to become photopositive; but magnesium sulphate had no effect. This suggests that the osmotic pressure does not determine the reaction. Addition of sodium sulphate had no effect on the reaction, but on the other hand addition of magnesium chloride caused an immediate reversal to a photopositive reaction, indicating that the concentration of chloride ions is the factor which determines the orientation of the larvæ to light. Potassium salts were lethal to the larvæ.

The habitat of *Polydora pulchra* has not been adequately described; it is not possible to say, therefore, whether the animal is a normal inhabitant of situations such as rock pools, where the salinity of the surface layers can be appreciably reduced by rain. The reversal of phototaxis in reduced salinity described above is, however, likely to have a survival value in such habitats by providing a mechanism for excluding the larvæ by day and perhaps by moonlight from surface layers when these approach a lethally low salinity.

I wish to express my thanks to Dr. D. I. Williamson, Mr. J. S. Colman and Mr. D. J. Slinn for their help in this work.

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Rephosphorylation produced by Inosine and Adenosine of Adenosine Monophosphate and Adenosine Diphosphate in Human Erythrocytes

The short survival of erythrocytes given by transfusion with stored donor blood is a problem of great current interest. The well-known steadily decreasing intensity of glycolysis in stored blood, despite excess of glucose, is easily explainable by a loss of adenosine triphosphate[1]. Gabrio *et al.*[1–3] have shown that addition of adenosine or inosine re-establishes the cell content of organic phosphate, increases the consumption of glucose, and thus the post-transfusion viability.

Since direct measurements of adenosine triphosphate, adenosine diphosphate and adenosine monophosphate in isolated blood cells are not available in the literature, detailed support for this explanation has not yet been established.

In fresh human blood stored at 37° C. the content of adenosine triphosphate in the red cells falls within a few hours, simultaneously with a transitory accumulation of adenosine di- and mono-phosphate, which are broken down to hypoxanthine 12–24 hr. after the withdrawal of the blood sample[4].

Table 1. Adenosine Tri-, Di- and Mono-Phosphate in Washed Red Blood Cells suspended in Glucose-free Tyrode–Salt Solution of 37° C. at Zero Time

Inosine was added at 4.30 hr. The reactions were stopped by deproteinization of aliquots at zero time and at various intervals

Time at 37° (hr.)	Adenosine triphosphate (μmole/l. red cells)	Adenosine diphosphate (μmole/l. red cells)	Adenosine monophosphate (μmole/l. red cells)	Total adenine nucleotides (μmole/l. red cells)
0.00	1,160	247	75	1,482
2.35	556	424	424	1,404
4.30	332	338	472	1,112
4.37	1,062	75	0	1,137
4.42	1,045	111	0	1,156
4.55	940	163	43	1,146

We have now been able to demonstrate the resynthesis of adenosine triphosphate from the mono- and di-phosphate at 37° C. in a glucose-free suspension of erythrocytes by the addition of inosine or adenosine. After centrifugation of about 100 ml. of fresh heparinized blood, the red cells were washed three times with glucose-free Tyrode–salt solution at 10° C., suspended at once in a solution heated to 37° C. and placed in a thermostat.

Adenosine tri-, di- and mono-phosphate were determined in 2-ml. aliquots of the blood-cell suspension, which was deproteinized with 1 vol. of trichloroacetic acid and measured by an enzymatic differential spectrophotometric method devised for the analysis of blood[4]. In the almost glucose-free medium, 50 per cent of adenosine triphosphate was broken down to the mono- and di-phosphate within 2½ hr., as shown in Table 1, the total concentration of adenine nucleotide remaining practically constant throughout this period. However, during the next two hours there occurred a pronounced breakdown of adenine nucleotide to hypoxanthine, as evidenced by the fact that 25 per cent of the total amount of adenine nucleotide disappeared within this period. After 4½ hr., a 10 m*M* solution of inosine was added, so that its initial concentration was 525 μmoles per litre of blood-cell suspension. The concurrent fall of the hæmatocrit value was only from 41 to 38·6 per cent.

The lower half of Table 1 shows that 7 min. after the addition of inosine, all the adenosine monophosphate and nearly all the diphosphate had been rephosphorylated to the triphosphate. The concentration of adenosine triphosphate remained constant during the following 5 min.; thereafter it fell slowly, simultaneously with a corresponding accumulation of the di- and the mono-phosphate. The resynthesis was repeated by renewed addition of the nucleoside after the concentration of triphosphate had fallen.

It is not surprising that the concentration of adenosine triphosphate can only be maintained for 5–10 min., because the ribose phosphate produced from inosine is soon used up, and no other substrate is present for continued glycolysis in the glucose-free environment.

By adding adenosine we observed, just as with inosine, a transitory resynthesis of adenosine triphosphate. The amount produced is shown in Table 2. For these experiments we used aliquots of the blood-cell suspension from the experiments illustrated in Table 1, to which, after standing for 4½ hr. at 37° C., we added different quantities of inosine or adenosine.

Table 2. Resynthesis of Adenosine Triphosphate produced by addition of Different Amounts of Inosine or Adenosine to aliquots of the Glucose-free Suspension of Red Cells after standing at 37° C. for 4.30 hr.

Nucleoside added	Initial conc. of added nucleoside (μmole/l. suspension)	Adenosine triphosphate resynthesized (μmole/l. red cells)	Disappearance of adenosine di- + mono-phosphate (μmole/l. red cells)
Inosine	175	405	436
"	350	675	677
"	525	730	735
"	700	782	755
"	1,150	789	760
Adenosine	175	380	391
"	350	650	637
"	525	758	745
"	700	890	727
"	1,150	934	750

Equimolar concentrations of inosine and adenosine up to 525 μmoles per litre of suspension give identical resynthesis of adenosine triphosphate. Addition of inosine exceeding 525 μmoles per litre does not effect any additional synthesis of triphosphate, because the total amounts of di- and mono-phosphate are rephosphorylated at the concentration stated (Table 1). In contrast to this, higher concentrations of adenosine yield an increased resynthesis of the triphosphate. Thus, concentrations of 700 and 1,150 μmoles adenosine per litre of the suspension yield a synthesis of adenosine triphosphate that is 25 per cent higher than the decrease of the sum of the mono- and di-phosphate. This indicates in all probability that adenosine acts partly like inosine[3], and partly as a substrate for a direct adenine nucleotide synthesis. The intense rephosphorylation of adenosine monophosphate is, as shown by one of us[4], due to the presence of myokinase (adenylate kinase) in the cells.

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Oxidation of 2,5-Diketogluconate by a Cell-free Enzyme Preparation from *Acetobacter melanogenum*

It has been reported by Katznelson *et al.*[1] that 'old' intact cells and cell-free extracts of *Acetobacter melanogenum* oxidize glucose to gluconate, 2-ketogluconate and finally to 2,5-diketogluconate. We have obtained evidence that this last compound can be oxidized further.

Cells of *A. melanogenum* grown in a medium containing 2 per cent potassium gluconate and 1 per cent yeast extract (48 hr., shake culture) were washed twice and suspended in *M*/20 phosphate buffer at *p*H 6·0 (1 gm. of cells in 5 ml.). The cell suspension was then subjected to sonic vibration for 10 min. in a 10-kc./s. sonic oscillator, centrifuged at 12,000 *g* for 10 min. and the supernatant used. This cell-free extract catalysed a one-step oxidation of 2-ketogluconate to 2,5-diketogluconate with an oxygen consumption of 0·5 μmole per μmole of 2-ketogluconate. However, on the addition of phenazine methosulphate a marked increase in oxygen consumption occurred (Table 1). It was then found that approximately 1·5 μmoles oxygen were consumed per μmole of 2,5-diketogluconate or 2·0 μmoles per μmole of 2-ketogluconate. At the same time it was discovered that 1 μmole of carbon dioxide was liberated per μmole of the diketo compound. It was also demonstrated chromatographically that 2,5-diketogluconate disappeared in the presence of phenazine methosulphate. Neither fluoride nor dinitrophenol (at concentrations of 10^{-2} *M* and 5×10^{-3} *M* respectively) prevented oxygen consumption and carbon dioxide production.

Table 1. Effect of Phenazine Methosulphate (PMS) on the Rate of Oxidation of 2-Keto- and 2,5-Diketo-gluconate

Warburg vessels contained 0·5 ml. enzyme, 0·2 ml. 2-ketogluconate (10 μ*M*) or 0·5 ml. 2,5-diketogluconate (5 μ*M*), 0·5 ml. phenazine methosulphate (1 mgm.) and *M*/20 phosphate buffer (*p*H 6·0); total volume 2·0 ml. Centre cup contained 0·2 ml. potassium hydroxide (20 per cent). Phenazine methosulphate and substrate were tipped into the main compartment at zero time.

Substrate	Oxygen uptake at 30 min. (μl.) Without PMS	With PMS
2-Ketogluconate	128	260
2,5-Diketogluconate	0	50

After oxygen uptake had ceased (140 min.) the reaction mixture was analysed by the method of Cavallini *et al.*[2] with 2,4-dinitrophenylhydrazine. Alpha-ketoglutarate was found to be a major end-product. Chromatographically, the hydrazones of pure α-ketoglutarate and of the reaction product were found to give identical R_F values in tertiary amyl alcohol/ethanol/water (9 : 1 : 2). When the hydrazones of the 'unknown' compound and of pure α-ketoglutarate were eluted with *M*/100 phosphate buffer (*p*H 7·0) from paper chromatograms and their absorption spectra determined, it was found that the maximum absorption band of both compounds coincided at 382 mμ. Samples were removed at intervals during the course of the oxidation for determination of pentose[3] and of α-keto acids[4]. A positive orcinol test was obtained up to the first 45 min., after which the pentose-like compound gradually disappeared, whereas α-keto acid production increased with time and at the end of the experiment approximately 50 per cent of the 2,5-diketogluconate could be accounted for as α-keto acid, presumably α-ketoglutarate.

When 2,5-diketogluconate was incubated with the cell-free extract anaerobically in the absence of phenazine methosulphate, carbon dioxide was liberated and a compound was produced (as the 2,5-diketogluconate disappeared) which had an R_F value not unlike that of arabinose. When the reaction mixture was exposed to air and phenazine methosulphate added, this pentose-like compound disappeared with the concomitant formation of α-ketoglutarate.

Specific sprays for ribulose[5], xylulose[5] and sedoheptulose[6] when applied to the reaction product from anaerobic experiments yielded negative results, suggesting that these substances were not formed. This applies also to dihydroxyacetone, except that more conventional sprays were used to detect this compound.

The results suggest that *A. melanogenum* can oxidize glucose to α-ketoglutarate via 2,5-diketogluconate and a pentose-like intermediate. It was also found that these extracts catalyse the conversion of L-arabinose to α-ketoglutarate, as reported recently by Weimberg and Doudoroff[7] with *Pseudo-*

monas saccharophilia. It is possible that the conversion of our pentose-like compound to α-ketoglutarate is a closely related phenomenon.

We are grateful to Dr. R. M. Hochster of this laboratory for his helpful suggestions and criticisms.

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Isolation of Adenylosuccinic Acid from *Penicillium chrysogenum*

While investigating the nucleotides occurring in the mycelium of *Penicillium chrysogenum*, Ballio, Casinovi and Serlupi-Crescenzi[1] detected, besides sixteen well-known derivatives of adenosine, guanosine, inosine, cytidine and uridine, several unidentified compounds. The structures of two of them have now been established, one being adenylosuccinic acid, the other the corresponding nucleoside.

The occurrence of adenylosuccinic acid in a living organism has not been previously reported. It was first prepared by Carter and Cohen[2,3] with a yeast enzyme that catalyses the reversible reaction between adenosine-5′-phosphate and fumaric acid, and was assigned the structure of 6-succinoaminopurine ribosyl-5′-phosphate. The same authors[4] showed that adenylosuccinic acid was also formed when a pigeon-liver homogenate supplemented with alpha-ketoglutarate, adenosine-5′-triphosphate, ribose-5-phosphate and aspartic acid was incubated with either inosine-5′-phosphate, or 4-amino-5-imidazolecarboxamide, or glutamine, glycine and formate. More recently, Lieberman[5] demonstrated that an enzyme from *Escherichia coli* B was able to synthesize adenylosuccinic acid from inosine-5′-phosphate, L-aspartate and guanosine-5′-triphosphate, and that an extract of the same organism cleaved the substance to adenosine-5′-phosphate. A possible role of adenylosuccinic acid in purine biosynthesis has been discussed by some authors[2,4,6].

The compounds described in the present communication were extracted from the mycelium of *P. chrysogenum* either with 50 per cent ethanol or with perchloric acid, and purified by ion exchange on 'Dowex-1' followed by paper chromatography. The absorption at 260 mμ of the eluate from the ion-exchange resin was measured continuously and recorded with a simple photometric apparatus developed in this laboratory as an attachment to a Hilger 'Uvispek' spectrophotometer[7]. The absorption spectra of both compounds in acid and in alkali were indistinguishable from the spectra reported by Carter and Cohen[2,3] for adenylosuccinic acid. The nucleotide had the same R_P as enzymatically prepared adenylosuccinic acid in three solvent systems. Using the molar extinction coefficient found by Carter and Cohen[2,3], it yielded the following molar ratios of base, pentose and phosphate: 1 : 1·05 : 1·07. On acid hydrolysis (1 *N* hydrochloric acid, 5 hr. at 60°), it gave a base and a pentose phosphate in equimolar amounts. The base had an absorption spectrum typical of a 6-substituted aminopurine[8,9] and was indistinguishable from synthetic 6-succinoaminopurine[10] in five different paper chromatographic systems which could easily differentiate a number of 6-substituted-aminopurines. Furthermore, the base gave, like 6-succinoaminopurine[10], a diazotizable amine when heated with 6 *N* hydrochloric acid (30 min. at 100°). The pentose phosphate was identified as ribose-5-phosphate by paper electrophoresis and by hydrolysis with the 5′-nucleotidase from bull seminal plasma[11], the pentose released being ribose. The position of the phosphate group was further confirmed by the positive reaction of the nucleotide with the periodate–benzidine reagent for alpha-glycols[12], and by treatment of the nucleotide itself with the 5′-nucleotidase from bull seminal plasma[11]. The latter treatment released 92 per cent of the calculated amount of inorganic phosphate and a substance moving on paper (four different systems) like the previously mentioned nucleoside found to occur in the mycelium together with adenylosuccinic acid. The naturally occurring nucleoside gave on acid hydrolysis (1 *N* hydrochloric acid, 5 hr. at 60°) 6-succinoaminopurine and ribose, and also yielded glycerol by degradation according to the procedure of Viscontini, Hoch and Karrer[13]; it has therefore been assigned the structure of 6-succinoaminopurine ribofuranoside.

We are indebted to Prof. E. B. Chain for his interest and encouragement throughout this investigation, and to Dr. C. E. Carter for a sample of adenylosuccinic acid.

Note added in proof. Joklik[14] has recently reported the isolation of adenylosuccinic acid and of 6-succinoaminopurine from mammalian liver.

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Anæsthetic Effect produced by Organophosphorus Compounds

During the study of the toxic action of the 'Metasystox' isomers (O,O-dimethyl-O-ethylthioethyl phosphorothionate and O,O-dimethyl-S-ethylthioethyl phosphorothiolate) pronounced anæsthetic effects were observed in rats after sublethal intravenous injection with both compounds. To find out if this anæsthetic property is shared by other organophosphorus compounds of low toxicity, other esters known to possess

Table 1. SYMPTOMS OBSERVED AFTER THE INTRAVENOUS INJECTION OF CERTAIN ORGANOPHOSPHORUS COMPOUNDS INTO FEMALE RATS (170–220 GM.)

Compound	Dose (mgm./kgm.)	Anæsthetic effect and other signs (duration)	Cholinergic symptoms
O,O-Dimethyl-O-ethylthioethyl phosphorothionate (thionate isomer of 'Metasystox')	200 (sublethal)	inco-ordination and pronounced weakness (about 1 hr.)	none
	250 (lethal)	deep anæsthesia with occasional jerkings (about 30 min.); dyspnœa (about 2 hr.)	none
O,O-Dimethyl-S-ethylthioethyl phosphorothiolate (thiolate isomer of 'Metasystox')	50 (sublethal)	moderate-pronounced weakness (5 min.)	pronounced, starting within 10 min.
	70 (3 died of 4)	pronounced weakness (> 5 min.)	very pronounced, starting within 5 min.
	100 (lethal)	anæsthesia and dyspnœa (5 min.)	very pronounced, starting within 5 min.
O,O-Dimethyl-S-(1,2-dicarbethoxyethyl) phosphorodithionate ('Malathion')	300 (sublethal)	slight inco-ordination and weakness (about 10 min.)	pronounced, starting after 15 min.
	600 (lethal)	anæsthesia with dyspnœa (10 min.). Respiratory failure	death occurred before cholinergic symptoms developed
bis-Dimethylamido-8-hydroxyquinolyl phosphate	250 (sublethal)*	deep anæsthesia with superficial respiration (40 min.); weakness (2 hr.)	pronounced, starting after 2–3 hr.
	500 (lethal)	immediate anæsthesia and respiratory failure	death occurred before cholinergic symptoms developed
Trimethyl phosphate	1,800 (sublethal)	inco-ordination and pronounced weakness (about 6 hr.)	none
	2,400 (lethal)	deep anæsthesia and dyspnœa (20 min.); pronounced weakness and sleepiness (> 24 hr.) followed by coma	none
Triethyl phosphate	500 (sublethal)	deep anæsthesia (4 min.); weakness and inco-ordination (2–3 hr.)	none
	1,000 (sublethal)	deep anæsthesia with superficial respiration (about 1 hr.); very pronounced weakness and dyspnœa (> 12 hr.)	none
Triethyl phosphorothionate	150 (sublethal)	anæsthesia (20 min.); moderate weakness (1 hr.)	none
	250 (lethal)	deep anæsthesia, pronounced dyspnœa (40 min.). Respiratory failure	none
Tributyl phosphate	80 (sublethal)	inco-ordination and mild anæsthesia (about 1 hr.); pronounced weakness (> 4 hr.)	none
	100 (lethal)	anæsthesia, pronounced dyspnœa (8–10 min.). Respiratory failure	none

* Immediate failure of respiration; natural respiration re-established by 1–2 min. artificial respiration.

little or no anticholinesterase activity were tested in a similar way. 'Malathion' and *bis*-dimethylamido-8-hydroxyquinolyl phosphate were chosen as weak inhibitors, trimethyl-, triethyl- and tributyl-phosphates and triethyl-phosphorothionate as compounds with no anticholinesterase activity.

All esters, except *bis*-dimethylamido-8-hydroxyquinolyl phosphate which was dissolved in distilled water (333 mgm./ml.), were injected undiluted into the rats' tail veins. Results are summarized in Table 1. Moderate or pronounced anæsthetic effects were produced immediately after injection of all tested compounds. At the same time respiration was more or less affected. In some instances it stopped and was only resumed after artificial respiration for 1–2 min. With compounds known to act as cholinesterase inhibitors cholinergic symptoms appeared but not before the animals had started to recover from the anæsthetic effect.

The compounds tested ranged in water solubility from completely miscible to very sparingly soluble; yet *bis*-dimethylamido-8-hydroxyquinolyl phosphate, miscible in all proportions in water, produces an effect at a similar dosage to 'Malathion', solubility 0·145 gm./l. Thus water solubility is not a determining factor.

It seems reasonable to assume that other organophosphorus compounds of low anticholinesterase activity will produce similar anæsthetic effect after sublethal intravenous injection. With more active cholinesterase inhibitors such an effect will be seldom observed because the dosage necessary to produce anæsthetic effects will be far beyond the lethal doses. The anæsthetic effect of 'Metasystox' isomers was observed only when carefully purified compounds were used. The methods of purification are to be published later[1]. They greatly reduce the intravenous toxicity to rats. In intermediate cases, where doses which produce cholinergic and anæsthetic symptoms are close to each other, a slight or moderate anæsthetic effect may be easily overlooked when masked by the immediate onset of pronounced cholinergic symptoms.

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Effect of Magnesium Ions on Heart-Muscle Transaminase

THE possibility that the activation of glutamic-oxalacetic apoenzyme by synthetic pyridoxal phosphate required the presence of a metal was considered by Cammarata and Cohen[1], after they had failed to reactivate the resolved transaminase to activity-levels comparable with those of unresolved preparations. Their examination of the emission spectra of ashed enzyme further suggested that magnesium or iron could possibly be involved. It has more recently been reported by Cohen[2], however, that an examination of the possible relation of trace-metals to transaminase activity has not been particularly revealing.

In view of recent evidence obtained in this laboratory by Beechey and Happold[3] for the exist-

ence of a pyridoxamine phosphate transaminase in *Esch. coli* which requires magnesium ions for the conversion of pyridoxamine phosphate to the pyridoxal ester, as well as the effect of monovalent cations upon enzymes the coenzyme of which is pyridoxal phosphate, a study of the mechanisms of transaminase action is now being undertaken. In preliminary work with glutamic-oxalacetic transaminase from sheep's heart muscle, evidence for the need for magnesium ions has been obtained.

The enzyme preparation was obtained according to the alcohol fractionation scheme of Cammarata and Cohen[1]. This procedure was carried out as far as 'Ppt. WFT-11', purification beyond this point being judged unnecessary for the present study. The enzyme was lyophilized and stored at − 18° C.

Assay of transaminase activity was carried out manometrically, and by a procedure similar to that employed by Meister, Sober and Peterson[4]. Decarboxylation of the oxalacetate formed from aspartic and α-ketoglutaric acids, however, was accomplished in most experiments by using aluminium ions[5].

The enzyme preparation (5 mgm.) was incubated with 0·5 ml. 0·05 *M* tris buffer *p*H 8, in the main compartment of a Warburg vessel at 37°. After 10 min. a side-arm containing 25 μM L-aspartic and 25 μM sodium α-ketoglutarate was tipped. After a period of 10–90 min., 0·5 ml. of $Al_2(SO_4)_3.18H_2O$ in 2*N* HCl (33·3 gm./100 ml.) was added from a second side-arm, and the volume of carbon dioxide evolved was recorded. In such an experiment with a series of Warburg vessels including controls, pairs of vessels were set up, one containing 0·1 ml. of 10 per cent magnesium sulphate solution. Each pair was tipped to decarboxylate oxalacetate after, say, 10, 30, 60 and 90 min. reaction time. Manometer readings were taken at frequent intervals after equilibration, and then for 10 min. after the commencement of decarboxylation. The results for reaction times of 30, 60 and 90 min. are shown in Fig. 1; the presence of magnesium ions increases the production of oxalacetate by as much as 80 per cent. The point at which the decarboxylating reagent was tipped, that is, the reaction time, is in the case of each curve indicated by the sudden evolution of carbon dioxide. Aniline citrate[6] has been used instead of aluminium ions in some cases and gives similar results.

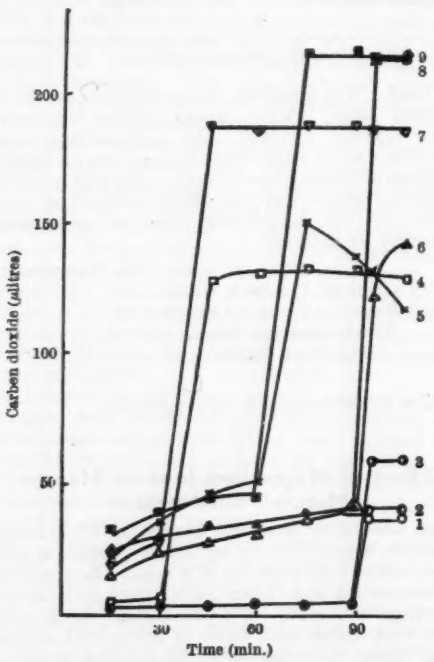

Fig. 1. Activity of enzyme preparation, as μlit. carbon dioxide produced by decarboxylation of reaction product, oxaloacetic acid. Curves 1, 2 and 3 are controls: 1, endogenous; 2, enzyme + α-ketoglutarate; 3, enzyme + aspartate. Curves 4 and 7 represent carbon dioxide liberated after reaction time of 30 min., in the absence and presence of magnesium ions respectively. Similarly, curves 5 and 9 correspond to a reaction time of 60 min., and curves 6 and 8 to a reaction time of 90 min. The point at which decarboxylation commences is, in the case of each curve, indicated by the sudden evolution of carbon dioxide

In this and other experiments under similar conditions, it has been found that the majority of the reaction product has been formed after 30 min. and that equilibrium has been reached after 60 min. The addition of pyridoxal phosphate (10 μgm.) has been observed to have no effect on activity, supporting the claim that the preparative procedure produces unresolved transaminase.

The addition of magnesium ions, however, at a final concentration of $1{\cdot}60 \times 10^{-2}$ *M*, has been found under the above conditions to increase activity by as much as 100 per cent, large increases in activity being associated with long reaction times.

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Nature of the Defect of Neuromuscular Transmission in Myasthenic Patients: 'Post-tetanic Exhaustion'

It is generally agreed that the muscular weakness and exaggerated proneness to fatigue characteristic of myasthenia gravis are related to a failure of neuromuscular transmission. The mechanism responsible for the block still remains obscure; but it is usually regarded as analogous to the process of curarization. The experiments reported here show that, although this analogy may hold for some features of transmission at the myasthenic neuromuscular junction, the main weakness observed after an effort is of a nature not shown in the curarized muscle.

If the electromyogram[1] and the isometric myogram[2] of myasthenic muscle are recorded during the excitation of the motor nerve at fairly low rates (say, 2–20/sec.), the successive responses are of decreasing amplitude (see *A*, Fig. 1), presumably because more and more individual neuromuscular junctions fail as a result of the preceding activity. This type of progressive neuromuscular block during a train of stimuli is also observed after administration of a competitive curarizing drug, in man and mammals. But such a block does not persist if the stimulation is interrupted for a few seconds, and for this very

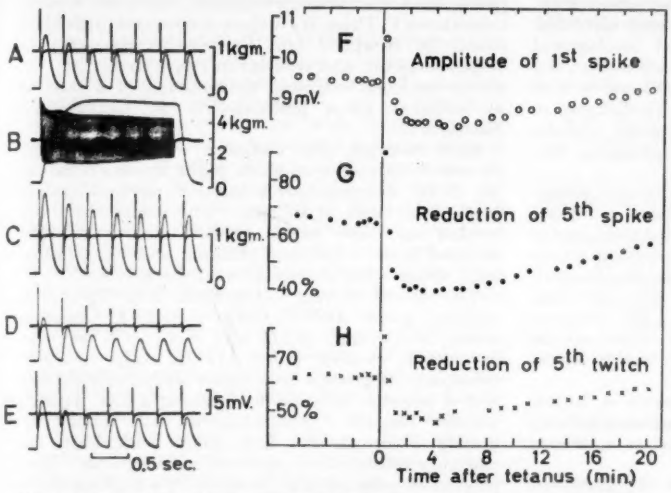

Fig. 1. Patient with moderate generalized myasthenia. Withdrawal of all medication 17 hr. earlier

A–E: Cathode-ray oscillograms of response of adductor pollicis muscle to supramaximal stimulation of ulnar nerve at the wrist; the rate is 3/sec. in *A*, *C*, *D* and *E*, and 50/sec. in *B*. Upper trace, electrical response recorded with belly-tendon surface electrodes. Lower trace, isometric myogram recorded with strain-gauge myograph. The ulnar nerve is blocked with xylocaine at the elbow in order to avoid reflex and voluntary interference in the neuromuscular responses. The intramuscular temperature, measured with a thermocouple, is kept between 34·2° and 35° C. with an infra-red lamp. Further explanations in the text.

F–H: Diagrams illustrating the time-course of post-tetanic decrease and increase of neuromuscular block, in the same experiment. *F*, amplitude in millivolts of negative phase of electrical response to a single shock. *G*, reduction of amplitude of the fifth electrical response in a train at 3/sec., expressed as a percentage of amplitude of first response. *H*, same as *G* for twitch peak tension

reason it cannot account for the enduring clinical fatigue which, in the myasthenics, persists for many minutes after a voluntary effort. It can only explain short-term clinical features such as the reduction of muscle power measured by a dynamometer, or the fatigue appearing during the maintenance of a posture.

The transmission process was studied in a different way by testing the response of myasthenic muscle to a short train of stimuli at 3/sec., after the motor nerve has been faradized at a rate of 50/sec. for 2 sec. (it may be pointed out that 50/sec. is within the range of discharge frequencies of motor units). Following this, two modifications of the 3/sec. responses are seen.

(1) 15 sec. after the tetanus (Fig. 1,*C*) the electrical[3] and mechanical responses are both substantially increased and the progressive depression of successive responses is much less evident. This post-tetanic improvement of neuromuscular transmission in myasthenics is probably related to the phenomenon of 'post-tetanic decurarization' described in curarized muscle[4,5]. The effect is short-lived and it disappears 20–30 sec. after the faradization. It is probably of minor clinical importance, but may account for the paradoxical improvement of motor performance of some myasthenics at the beginning of a series of voluntary contractions.

(2) In contrast with the above, 4 min. after the tetanus (Fig. 1,*D*) both electrical and mechanical responses are reduced, and the depression of successive responses is now much more prominent. The muscle recovers slowly, and 27 min. after the tetanus (Fig. 1,*E*) it has nearly returned to its prefaradization state. The remarkable feature of myasthenia is indeed that the neuromuscular block does not return to its previous level after the transient improvement mentioned above, as it does in the curarized muscle. Instead the block increases during the 2–4 min. after the tetanus (shown in Fig. 1.*F*, *G* and *H*). Afterwards this 'post-tetanic exhaustion' slowly disappears with a half-time of 10–15 min. This is just about the time required to observe an appreciable clinical recovery of voluntary performance after a short exertion both in this patient and in a number of others. The effect is regularly seen in myasthenic muscles and has been found also in a patient who had never received any treatment for myasthenia (such as anticholinesterase drugs) up to the time of the experiment.

The enduring and reversible increase of neuromuscular block after a short period of intense activity in myasthenics, which has been recorded in the above experiments, can thus be fairly considered as the analogue of the long-lasting component of the pathological fatigue seen clinically. The fact that this phenomenon is not observed in curarized muscle must be stressed, since it is important evidence indicating that the nature of the neuromuscular block is different in the two conditions. It shows that a simple decrease in end-plate sensitivity to acetylcholine cannot account for the whole myasthenic disease process, not even for its most characteristic clinical feature. The 'post-tetanic exhaustion' might result from depletion and deficient resynthesis of preformed acetylcholine in nerve endings, or from an enduring alteration of chemoreceptor mechanism at the end-plate.

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Hyperparasitic Chain of a Fungus, a Bacterium and its Phage on Wheat

In the field of plant pathology, hyperparasitism is an uncommon phenomenon. Recently, Pon *et al.*[1] have reported on a new bacterial parasite of the rust fungi, *Puccinia* spp. Since the latter are widespread pathogens for wheat, the bacterium involved may be regarded as a secondary parasite.

The American authors have found this hyperparasite in the United States (1954) and suggested the name *Xanthomonas uredovorus* for it. We have

also succeeded in isolating the same bacterium from Hungarian rust populations in 1955, and identified it on the basis of morphological and biochemical characters. It damages our rust cultures in the greenhouse and under favourable conditions is able to spread to an extent that makes it difficult to produce rust uredospores and to identify physiological races of stem rust (*Puccinia graminis* var. *tritici*).

In the course of our investigations on the wheat-rust–bacterium complex, we have isolated a further hyperparasite, which is a bacterial virus parasitizing *X. uredovorus*. In cultures of *X. uredovorus* grown on 0·75 per cent agar medium (glucose–broth–agar), the bacteriophage forms clear plaques of 0·7–1·0 mm. in diameter with ill-defined margins. The phage is species-specific, since it is unable to infect several other *Xanthomonas* spp. including *X. malvacearum*, *X. carotae*, *X. phaseoli* var. *fuscans*.

This host–parasite complex represents a hyperparasitic chain, terminating in the phage as a tertiary parasite, and beginning with the wheat as a tertiary host.

We have not been able to find in the literature any previous reference to such a twofold hyperparasitism in the plant kingdom. It involves three host–parasite relationships the further study of which may explain the sudden alterations in rust populations and in the outbreak of epidemics.

Detailed accounts of this work will be published elsewhere.

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d-Gallocatechin from the Bark of *Casuarina equisetifolia* Linn.

Gallocatechin, or 5′-hydroxycatechin, was first isolated from Japanese green tea by Tsujimura[1] in 1934, and later shown by Bradfield and Bate-Smith[2] to be *l*-epigallocatechin. *d*-Gallocatechin was obtained by Oshima (Osima)[3] in 1939 from the bark of Formosan *Casuarina equisetifolia* and termed 'casuarin'.

The bark of *Casuarina equisetifolia* has since been investigated as a source of *d*-gallocatechin by Roux[4], who found that 'casuarin' could be isolated in 0·04 per cent yield (melting point 181° C., blue-green coloration with ferric chloride, as found by Oshima (*loc. cit.*)) from *C. equisetifolia* established in Zululand. However, examination by paper chromatography using butanol/acetic acid/water (4 : 1 : 5) showed that 'casuarin', even after repeated recrystallization from water (white silky needles), could be resolved into two components, one of which gave a blue coloration ($R_F = 0·57$) and the other a green coloration ($R_F = 0·76$) with 1 per cent ferric chloride spray. Both constituents gave an intense red-violet coloration with vanillin–toluenesulphonic acid spray after heating (80° C.), indicating the probable presence of phloroglucinol nuclei in each. (Resorcinol and pyrogallol nuclei also give similar, but much weaker, colorations.) These R_F values correspond with those found by Bradfield and Bate-Smith (*loc. cit.*) for *dl*-gallocatechin and *d*-catechin respectively, and the above evidence indicated the presence of a catechin in addition to a gallocatechin in recrystallized 'casuarin'.

More recently, this 'casuarin' was separated into its two constituents on thick paper sheets (Whatman No. 3) by the preparative method, using *n*-butanol/acetic acid/water as irrigant. The components were located as dark bands under ultra-violet light, stripped with 70 per cent ethanol, and recrystallized from water after evaporation of the solvent.

The slower-moving component has $R_F = 0·57$, melting point 183° C., $[\alpha]_D = +13·1°$ (acetone/water, 1 : 1), $\lambda_{max.} = 271$ mμ, $E_{max.} = 1,734$; Ac_8-derivative, melting point 143° C., $[\alpha]_D = +30·0°$ (acetone). It gives a blue colour with ferric chloride, and a positive reaction for phloroglucinol with the vanillin reagent. Micro-fusions with alkali yield mainly phloroglucinol and gallic acid, both conclusively identified on paper chromatograms. These properties establish the presence of a *d*-gallocatechin with properties somewhat different from those found by Oshima (compare above).

Similarly, the faster-moving component has $R_F = 0·76$, melting point 172° C., $[\alpha]_D = +13·2°$ (acetone/water, 1 : 1). $\lambda_{max.} = 280$ mμ, $E_{max.} = 4,061$; Ac_8-derivative, melting point 131° C., $[\alpha]_D = +31·9°$ (acetone). It gives a green coloration with ferric chloride spray, a positive reaction for phloroglucinol. Micro-fusions with alkali yield mainly phloroglucinol and protocatechuic acid. (Found: for *d*-catechin isolated from gambier extract from the leaves and twig of *Uncaria gambir*: $\lambda_{max.} = 280$ mμ, $E_{max.} = 3,986$; Ac_8-derivative, mixed melting point with corresponding derivative, above, 131° C.) This establishes the presence of *d*-catechin.

Furthermore, *d*-gallocatechin and *d*-catechin from 'casuarin' were spotted on to separate two-dimensional paper sheets and suitable concentrations of the ethyl-acetate extract of green tea leaves (previously extracted with chloroform) superimposed on each spot. After two-dimensional chromatography using the same solvents as Roberts and Wood[5], an increase in the concentration of those spots attributed to *d*-gallocatechin and *d*-catechin by Roberts and Wood was observed in each instance. Similarly, the presence of both *d*-gallocatechin and *d*-catechin was established in the bark of *Casuarina equisetifolia* obtained from Formosa (Taiwan).

Recently, Mayer[6] isolated *d*-gallocatechin from the barks of both the oak and sweet chestnut in sufficient yield to characterize and compare these compounds. The physico-chemical constants obtained by Mayer for *d*-gallocatechin (melting point, 185–188° C., $[\alpha]_D = +14·7°$; Ac_8-derivative, melting point 141–143° C., $[\alpha]_D = +31°$ C.; Me_8-derivative, melting point 160–162° C., $[\alpha]_D = -3·0°$) differ in all cases from those of Oshima's 'casuarin'. Mayer directed attention to this and suggested a reinvestigation of 'casuarin'. Samples of *d*-gallocatechin and hexacetyl-*d*-gallocatechin, kindly made available by Dr. Mayer, enabled a direct comparison with *d*-gallocatechin from both sources. One-dimensional chromatograms using the following irrigants showed identical R_F for the *d*-gallocatechins in each instance: butanol/acetic acid/water (4 : 1 : 5), $R_F = 0·57$; water-saturated phenol, $R_F = 0·18$; water only, $R_F = 0·28$; water-saturated *sec.*-butanol, $R_F =$

0·53. Also Ac_8-derivatives, mixed melting point, 143° C.

These *d*-gallocatechins from different sources may, therefore, be regarded as identical. Oshima's original 'casuarin', therefore, possibly consisted of a mixture of *d*-gallocatechin and *d*-catechin, as (*a*) 'casuarin' gave a blue-green coloration with ferric chloride, compared with the distinct blue and green colorations furnished by *d*-gallocatechin and *d*-catechin respectively, and (*b*) Oshima also did not report the separation of the *d*-catechin, which appears essential from the above findings. Alternatively, Oshima's physico-chemical constants could be incorrectly reported, should the *d*-catechin content of the bark of *C. equisetifolia* be so variable as to be abnormally low or absent under certain conditions.

Thanks are due to Dr. Walter Mayer, Chemisches Institüt der Universität, Heidelberg, for samples of *d*-gallocatechin and hexacetyl-*d*-gallocatechin; to the Union Department of Forestry, Pretoria, for kindly identifying and supplying the bark of *C. equisetifolia* from Zululand; to Mr. Y. K. King, Department of Forestry, Taiwan Provincial Government, Taipei, Taiwan, for an authentic sample of the bark of the same tree; and to the Chemistry Department, Rhodes University, for the use of a Hilger polarimeter.

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Androgenic Haploids of a Toad, *Xenopus laevis*

ANDROGENIC haploids of *Xenopus laevis* have been made using Porter's technique[1]. Fertilized eggs were obtained from a pair of toads which had previously been injected with a commercial preparation of anterior pituitary-like gonadotropins (350 I.U. for female, 150 I.U. for male). All operations on eggs were carried out at room temperature in a 100 per cent Holtfreter solution.

Fertilized eggs had most of the jelly coat removed and were then held, animal pole up, in a hemispherical egg-sized depression by a glass loop. A glass needle, finely pointed on a de Fonbrune microforge, was inserted at the white spot marking the position of the second polar body any time up to ½ hr. after laying. The needle was then drawn up slowly so that a small exovate containing the ovum nucleus was released. The jelly coat was self-sealing, but some yolk did leak into the space between egg and vitelline membrane.

The number of haploids surviving at least to hatching was 25 out of 94 operations. 100 per cent of the controls survived. The criteria for determination of haploidy were the obvious external symptoms of the haploid syndrome[1], together with a comparison of nuclear size with normal diploids of the same age. 100 nuclear diameters were measured in each of seven post-neurula tadpoles of which two representatives are given below.

		Mean (μ)	S. deviation	Age (days)
1.	Diploid	9·09	1·50	5
2.	Haploid	6·71	0·89	5

Such differences are to be expected if haploid nuclei have half the volume of diploid nuclei.

I should like to acknowledge the help and advice given me by Dr. L. G. Bell and financial help from the British Empire Cancer Campaign.

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Formation of Starch in Young Maize Kernels

THE starch laid down in all maize kernels contains both amylose and amylopectin, except in the case of 'waxy maize' the starch of which contains no amylose or at most an amount too small for detection with certainty. It might therefore be assumed that waxy maize differs from other maize in being unable to synthesize amylose. This, however, is not the case.

The first formation of starch in young kernels may be observed by the method of Duvick[1] and of Hori[2], which consists in the incubation of thin slices of the immature (starch-free) kernels in a solution of glucose-1-phosphate, then staining them with iodine. Under the microscope newly formed starch appeared as discrete, blue-stained granules (indicating amylose) with the maize used by the previous authors. We expanded these experiments using slices from starchy, waxy, sugary waxy, and sugary high-amylose[3] varieties of maize, and employing several sugars and sugar phosphates as substrates.

It was observed that normal starch synthesis had not yet begun in kernels of either starchy or waxy maize at 5–7 days after pollination, by testing control slices cut from the same kernel. The formation of starch granules was, however, observed in such slices after incubation with 1 per cent glucose-1-phosphate at 15° C. for 24–48 hr. Contrary to expectation, the waxy, as well as the starchy, variety formed granules that stained blue with iodine.

In kernels 10–12 days after pollination normal starch synthesis had already begun, and all control slices showed the presence of starch granules in some of the endosperm cells. Slices cut from the starchy variety contained starch granules that stained blue with iodine and slices from the waxy variety contained starch granules that stained red with iodine (amylopectin). After incubation with 1 per cent glucose-1-phosphate at 15° C. for 24–48 hr., the cells of the endosperm of the starchy variety were filled with starch granules which stained blue with iodine. The cells of the endosperm of the waxy variety, after similar incubation with 1 per cent glucose-1-phosphate, were also filled with starch granules, some of which stained blue with iodine while others showed a red centre and blue outer layer. Neither glucose (10 per cent) nor sucrose (10 per cent) nor any of the following (at 1 per cent levels) was effective for the formation of starch granules of either type: glu-

cose, fructose, sucrose, maltose, maltotriose, glucose-6-phosphate and fructose-1,6-diphosphate.

For the sugary waxy and sugary high-amylose varieties of maize, slices were cut from kernels 13–14 days after pollination; these did not contain any starch before incubation. After incubation with 1 per cent glucose-1-phosphate at room temperature for 3 hr. the slices of both varieties showed the presence of generally distributed unorganized polysaccharides that stained red with iodine, but no granules whatever. After 15 and 24 hr., slices of both varieties still contained amorphous polysaccharides that stained red, but also small starch granules all of which stained blue with iodine. Glucose, sucrose, maltotriose and glucose-6-phosphate were again ineffective in the formation of the granules. Oxygen likewise had no effect on their formation.

It is clear from these results that the endosperm of waxy maize has the ability to form amylose from glucose-1-phosphate by a reaction resembling that of phosphorylase, even though no amylose is detectable in the normally growing plant. The most logical explanation seems to be that the waxy variety growing under natural conditions may have some device which effects complete conversion of amylose to amylopectin[4], whereas in the other varieties tested the mechanism is far less efficient. Why this mechanism does not function under the laboratory conditions here described is not yet apparent.

The kindness of Dr. H. H. Kramer of Purdue University in furnishing samples of high-amylose maize for this study is most gratefully acknowledged.

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Corticium solani—an Orchid Endophyte

Corticium solani (Prill. and Delacr.) Bourd and Galz, the soil-inhabiting basidiomycete which attacks a wide range of hosts, has been isolated repeatedly by me in sterile mycelial form (*Rhizoctonia solani*) from the roots of the marsh orchid, *Orchis purpurella* T. and T. A. Steph. Germination tests with the seed of the orchid show that the mycelium of *R. solani*, so isolated, acts as a symbiont stimulating the growth of the embryos. Typical pelotons form within the orchid cells, and later digestion of the hyphæ takes place. Thus the fungus conforms to the normal conditions of an orchid endophyte.

Parasitic forms of this fungus isolated from diseased crop plants also proved acceptable symbionts. In germination tests the following isolates stimulated the growth of *Orchis purpurella* seed: *C. solani* from wheat straw (the Commonwealth Mycological Institute No. 39,933), *R. solani* from cauliflower (received from A. Channon, National Vegetable Research Station, Wellesbourne), and *R. solani* from tomato. On the other hand, a form isolated from potato did not enter the embryo, so that no growth-stimulation took place. Those tests prove that forms of the parasitic fungus *C. solani* can act as endophytes of the orchid *O. purpurella*, and it is of interest to note that last summer a plant of *O. purpurella* was found bearing the collar-like fruit-body of a corticium on the stem at ground-level. This condition is familiar in the case of potatoes attacked by the fungus but has never before been recorded on an orchid. The fruit-body was more tenuous than that found on potato and unfortunately was incompletely developed, but measurements of hyphæ and of young basidia are comparable with those on potato at a similar stage of development. An extensive search of other *O. purpurella* plants failed to reveal another plant bearing the fruit-body.

While *Rhizoctonia* spp. have been isolated repeatedly from terrestrial orchids, none of these, so far as I know, has been linked with a known parasitic species, and on no previous occasion has the corticium stage been recorded occurring naturally on an orchid stem.

A further interest lies in the light this finding throws on the soil ecology of orchid endophytes. These are generally classified with other mycorrhizal fungi as 'root-inhabiting' forms with a limited distribution in the soil[1]. On the other hand, *C. solani* is known to be widely distributed in the soil[2,3] and is therefore grouped with the saprophytic sugar fungi as 'soil-inhabiting'. Now that it is known that *C. solani* is a commonly occurring endophyte of *O. purpurella*, it may be found that other orchid endophytes also fall into the latter category.

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Mass Isolation of Viable Wheat Embryos

Commercial wheat germ has been a material of choice for biochemical studies ever since its use in the isolation of cytochrome *c* and cytochrome oxidase[1]. For purposes of physiological research, however, the commercial product has a serious limitation, namely, its non-viability. Samples of commercial material were tested for viability by sprinkling the germ on agar plates, or on filter paper moistened with glucose solution. Less than 0·5 per cent of the embryo-like particles showed signs of incipient germination, and none showed development of the cotyledon. Hand isolations of individual wheat embryos have been reported. Such embryos were used, for example, in mapping the intracellular distribution of hexokinase[2]. Hand picking, however, is a tedious and time-consuming process, and we therefore undertook to find a convenient means of preparing laboratory quantities of viable material. As a result, a simple procedure for isolating wheat embryos in relatively large amounts has been developed. One operator can prepare 200–250 gm. in a day. Chinook, a spring wheat, was found to be the most suitable of the several varieties tested.

About 250 gm. of wheat is mixed with 150 ml. of ½-in. lumps of 'dry ice' and after a few minutes the whole is ground for 20 sec. in a quart-size aluminium

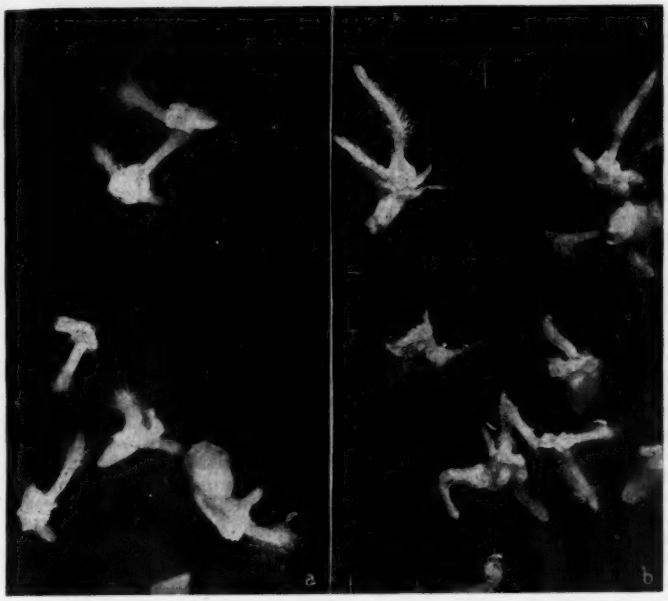

Fig. 1. Growth of isolated wheat embryos on agar medium. (*a*) Three days after planting; (*b*) five days after planting

Waring blendor jar. With larger amounts of wheat or longer grinding times, an appreciable proportion of the germ is destroyed. The mixture is screened on a set of sieves, 10-, 14-, 28-mesh (Tyler scale), and the portion remaining on the 10-mesh sieve is returned at once to the blendor, with enough 'dry ice' to keep the mixture well below 0° C. Usually, an additional 50 ml. of 'dry ice' is sufficient. The 20-sec. grinding and the screening are repeated twice. The embryos, which are freed quickly in the course of grinding, pass through the 10- and 14-mesh sieves. Many of the small fragments of endosperm from which the embryos have been detached pass through the 10- but not the 14-mesh sieve. Use of the 10-mesh sieve obviates regrinding of these fragments and so reduces the amount of endosperm passing through with the embryos. After thorough shaking of the sieves, only the 14- to 28-mesh portion is saved. This portion weighs about 25 gm. and contains 2·5 gm. of whole embryos. Since 1·5 per cent of the wheat seed is embryo, the yield at this stage is about 65 per cent. Further purification cannot be achieved by sieving. Usually, forty such concentrates of whole embryos were collected for subsequent processing.

The bran is removed by means of a seed blower. The germ is then separated from endosperm by stirring the mixture into a 2 *M* sucrose solution, allowing the suspension to settle and skimming the embryos off the surface. This step is repeated three times. The germs thus isolated are given two or three quick washes with ice-water on a sieve, blotted dry and air-dried. Alternatively, a mixture of cyclohexane – carbon tetrachloride (10 : 25 by volume) may be used in place of the sucrose to float off the germ. Both products were tested for starch content according to the method of Nielsen[3]. For the sucrose-floated germ the average starch content was 16 per cent. This could be reduced to 8 per cent if 1·9 or 1·8 *M* sucrose was used, but at the expense of a slightly lower yield. Embryo preparations floated on the organic solvent mixture had the lowest starch content, about 5 per cent. By contrast, a special sample of commercial germ made available to us for experimental purposes contained 22 per cent of starch; frequently, starch contamination of commercial preparations is as high as 40 per cent.

Germination tests were carried out on plates of 0·9 per cent agar containing 1 per cent glucose and 0·01 per cent streptomycin. All preparations obtained by the procedure described proved to be viable, more than 90 per cent of the embryos germinating. Most of those which failed to germinate were found to have been broken in the course of preparation. Growth of the different samples was followed for several days. All germinated embryos showed normal development of roots and root hairs. The streptomycin had no apparent effect on chlorophyll development, since the first leaf, when about 1 cm. long, was clearly green. Typical results of germination tests are illustrated in Fig. 1.

It was somewhat surprising that embryos floated off from a mixture of organic solvents were unaffected in viability. Indeed, if the solvents had any effect it was in the direction of accelerating germination, but this property was not further studied. It will be shown elsewhere, however, that embryos thus isolated have certain advantages over sucrose-floated ones for the purpose of preparing isolated nuclei[4].

Thanks are due to members of the Cereal Crops Division for supplying a number of wheat varieties and for use of a seed blower; also to Dr. H. Katznelson, of the Bacteriology Division, for performing the germination tests.

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Genetical Interference in Maize

Back-cross linkage data in maize involving three or more genes have been analysed to examine them from the point of view of consistency with Owen's theory[1–3] of genetical recombination. As a measure of interference, the Kosambi coefficient[3] K has been used. In a back-cross experiment involving two segments AB and BD, let y_1, y_2 be the recombination values for each segment, y_{1+2} the recombination value for the entire segment AD, and y_{12} the frequency of simultaneous recombination in both seg-

ments, then K is given by $\frac{y_{12}}{2y_1y_2y_{1+2}}$. Kosambi[4] has proposed the relation $2y = \tanh(2x)$ to relate the map distance x and the recombination fraction y between two loci. When $K = 1$, Kosambi's relation is satisfied. Owen[1-3] has expressed x and y in terms of a metric u in which interference is uniform, and has postulated the interference function $f(u) = 4u\exp(-2u)$ as an adequate fit to the observed data. Assuming this form for the interference function, $K = 1$ at the metrical mid-arm of long chromosome arms (> 40 cM.). The map-length of a segment from centromere to mid-arm is then given by

$$\tfrac{1}{2}T\tanh 2T + \frac{1 - \cosh 2T}{4\cosh 2T}$$

where T is metrical arm-length[1].

Graphs have been plotted of the arithmetic mean of map-distance for each triplet of genes against K for each chromosome. On the whole, with the exceptions of chromosome 3, for which the data are inadequate, and chromosome 8, for which there are no data, $K = 1$ at the metrical mid-arms assuming the centromere locations of Anderson and Randolph[5]. K exceeds one in the proximal half of the arms and drops below unity distal to the mid-arms.

From this analysis it is legitimate to conclude that the hypotheses of (i) no interference across the centromere, (ii) independent distribution of intercept lengths when measured on an interference metric, (iii) no repressive effect of terminus on chiasma formation, are consistent with the data so far as they go. The data support the hypothesis that the interference function can be represented by $4u\exp(-2u)$, but they are of insufficient accuracy to detect any small deviations from this function. In *Drosophila*, Owen[1] came to similar conclusions for chromosomes II and III, but the data for the X-chromosome were anomalous. Additional data are needed to clarify the situation in this chromosome.

A full account of this work will be published elsewhere. I wish to acknowledge the award of the Barr Smith Scholarship from the University of Adelaide.

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Use of Tetratype Frequencies for estimating Spindle Overlapping at the Second Division of Meiosis in 'Ordered' Tetrads

With ordered tetrads, such as occur in the asci of *Neurospora crassa*, the second-division meiotic spindles do not overlap (Fig. 1*a*) and the subsequent mitotic spindles are also well separated, with the result that analysis of the sequence of spores within the ascus allows a distinction to be made between first- and second-division segregation for a particular pair of alleles. With unordered tetrads, second-division segregation frequencies can be calculated from the frequencies of tetratype tetrads (for example, AB, ab, Ab, aB) for three independent loci, A/a, B/b and C/c, considered in pairs (A and B, B and C, C and A)[1]. When there is uncertainty whether the tetrads of a particular organism are ordered or not, use can be made of tetratype frequencies to estimate the frequencies of partial and complete spindle overlapping at the second division of meiosis. It is important to recognize such overlapping, since it may lead to inaccurate mapping of the centromeres, and, moreover, partial spindle overlap may mimic the effects of two-strand double cross-overs across the centromere. Thus the excess of such cross-overs found by Lindegren and Lindegren[2] in *N. crassa* has been attributed[3] to spindle overlapping, although there is good genetic evidence that such overlapping is not responsible[4].

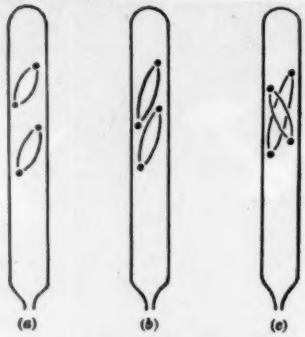

Fig. 1

Let p be the frequency of second-division segregation for a particular locus A/a, then the frequency of first-division segregation will be $1 - p$. Let r and s be the observed frequencies of asymmetrical (*AaAa* and *aAaA*) and symmetrical (*AaaA* and *aAAa*) 'second-division' spore-arrangements, respectively. Let x and y be the frequencies of partial and complete spindle overlap, respectively, at the second meiotic division. The effect of partial overlap (Fig. 1*b*) is to exchange tetrads between the first-division (*AAaa* and *aaAA*) and the asymmetrical second-division classes. Complete spindle overlap (Fig. 1*c*) leads to a transfer of tetrads from the symmetrical to the asymmetrical second-division classes; from the asymmetrical second-division to the first-division classes, and from the first-division to the symmetrical second-division classes. Each transfer will be in proportion to the magnitude of the class concerned. These effects are shown in Table 1 and may be expressed algebraically as

$$r = \frac{p}{2} + (1-p)x + \frac{p}{2}(y) - \frac{p}{2}(x+y)$$

$$= \frac{p}{2} + \left(1 - \frac{3p}{2}\right)x \quad \text{or} \quad x = \frac{2r-p}{2-3p}$$

and $$s = \frac{p}{2} + (1-p)y - \frac{p}{2}(y)$$

$$= \frac{p}{2} + \left(1 - \frac{3p}{2}\right)y \quad \text{or} \quad y = \frac{2s-p}{2-3p}$$

It is evident that partial overlap has no effect on the frequency of symmetrical second-division spore arrangements, and complete overlap has no effect on

Table 1

Type of segregation	Frequency	Effects of partial and complete spindle overlap	Type of spore arrangement	Frequency
First division	$1-p$	$(1-p)x$	'First division'	$1-r-s$
		$(1-p)y$		
Asymmetrical second division	$p/2$	$(p/2)x$	Asymmetrical 'second division'	r
		$(p/2)y$		
Symmetrical second division	$p/2$	$(p/2)y$	Symmetrical 'second division'	s

Table 2

Locus	p (per cent)	$2r$ (per cent)	x (per cent)	$2s$ (per cent)	y (per cent)
Yellow-1	1·0 to 6·2	27·7	11·9 to 13·6	12·5	3·5 to 5·8
White-2	8·1 to 12·5	27·0	8·9 to 10·7	12·2	−0·2 to 2·3
Brown	8·1 to 14·6	22·6	5·1 to 8·2	11·3	−2·1 to 1·8
Pale	10·8 to 14·6	20·2	3·6 to 5·6	17·8	2·0 to 4·2
Pink	37·3 to 39·6	42·0	3·0 to 5·3	48·0	10·3 to 12·1
Yellow-2	40·6 to 41·6	47·1	7·3 to 8·3	37·7	−5·2 to −3·7

the frequency of asymmetrical second-division spore arrangements. For proximal loci (second-division segregation frequency less than two-thirds), partial overlap will add to the asymmetrical 'second-division' classes of spore arrangements and complete overlap will add to the symmetrical classes. Partial overlap is usually recognized[5,6] by an excess of the asymmetrical over the symmetrical 'second-division' spore arrangements, but it is evident that if the two kinds of overlap occur with equal frequency this method will fail. On the other hand, tetratype frequencies are independent of spindle overlap and hence second-division segregation frequencies based on them provide a reliable method of detecting spindle irregularities in supposedly ordered tetrads.

The following example shows the use of the tetratype method. In Table 2 are given values of p, $2r$ and $2s$ for six loci in *Venturia inaequalis* taken from the data of Boone and Keitt[5]. The values of p have been calculated from the published tetratype frequencies[7]. A range of values is given because the relative positions of the linked loci white-2, brown and pale cannot be determined from the data. If there is no spindle overlapping at the second division of meiosis, the values of p, $2r$ and $2s$ should be statistically equal for each locus. An excess of $2r$ over p is apparent for all six loci and, moreover, the excess is greatest for those loci where p is small. This is to be expected with partial spindle overlap, since if p is small, exchange of asci between the large first-division and the small asymmetrical second-division segregation classes will add appreciably to the latter. The values of x, calculated by means of the expression above, range from about 4 to 13 per cent, with a mean of 7·6 per cent. This mean value is significantly greater than zero ($t=5·85$, $n=5$, $P<0·005$). There is an excess of $2s$ over p for some of the loci. The values of y range from about −4 to 11 per cent, with a mean of 2·6 per cent. (Negative values of y are no doubt due to sampling error.) The mean value is not significantly greater than zero ($t=1·22$, $n=5$, $P=0·1$–$0·15$). It thus appears that partial overlapping of the second-division meiotic spindles occurs on the average in 7·6 per cent of asci of *Venturia*. There is also a suggestion that complete overlapping may occur in certain strains, though not in all, but this requires confirmation.

This tetratype method could usefully be applied to *Ascobolus stercorarius*, where Bistis[8] has detected the occurrence of partial spindle overlap at the second meiotic division by demonstrating that there is an excess of asymmetrical over symmetrical 'second-division' spore arrangements. Moreover, he has shown that such overlapping occurs more frequently at low temperatures (6°-7° C. and 14°–16° C.) than at 24°–25° C. It is claimed that the frequency of crossing-over is also increased at the lower temperatures; but similar results would be obtained if at low temperature there was an increased frequency of complete overlapping of the second-division spindles, the possible occurrence of which appears to have been overlooked.

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Occurrence of the Leathery Turtle in the Northern North Sea and off Western Norway

During the late summer of 1956, three specimens of the leathery turtle or luth, *Dermochelys coriacea* (L.), were captured by Norwegian fishing vessels. The first of these was observed on July 28, swimming slowly northwards at a position of 60° 31′ N., 3° 50′ E., that is, about thirty miles off Skarvöy (county of Hordaland). Catching it took 2½ hr., during which time the animal dived repeatedly to three to five fathoms and was constantly accompanied by three or four pilot fishes (*Naucrates*). The specimen was a male, probably an adult, measuring 2,015 mm. from snout to tip of tail; length of carapace 1,530 mm., greatest width 865 mm. The weight was 390 kgm.

The second specimen was captured in a tunny seine-net on September 7 at about 60° 24′ N., 4° 35′ E., that is, ten miles west-north-west of Lönöy (Hordaland). It was kept on board until the next day, when it died. This specimen also seemed to be rather vigorous and was likewise accompanied by three pilot fishes until the moment when it was hauled on board the vessel. This proved to be an adult female specimen; total length 1,850 mm., length of carapace 1,445 mm., greatest width of carapace 940 mm. and weight 396 kgm.

Both these specimens have been received by the Zoological Museum in Bergen and are preserved there.

Some days later, I received information about a third leathery turtle that had been harpooned during the basking-shark fishing forty miles north-east of

North Flugga, North Shetland, on September 5. This specimen had unfortunately been thrown overboard again; but the report from the fishermen with a detailed description of the turtle excludes any doubt about the species. The weight had been estimated at more than 300 kgm.

The three specimens in question most probably came in from the Atlantic north of Shetland, following the strong inflow of Atlantic water in this area.

So far as I know, there are no previous records of the leathery turtle from the northern North Sea. Single specimens of accidental stragglers have now and then visited French and British waters. A few have also appeared in the southern part of the North Sea, but these have more often been recorded dead or stranded on the coast. The present captures seem to be the more remarkable in that they have taken place at short intervals within a comparatively limited area and very far north. The finds may be taken to indicate that a more extensive movement of leathery turtles has taken place in the North Atlantic lately. This suggestion may perhaps be supported by new and supplementary records from other waters.

A more detailed account will be given in a Norwegian periodical.

Note added in proof. I have now obtained information about a fourth record of the leathery turtle off western Norway. It was observed by a tunny fisher on July 31, 17 miles west of Bulandet, county of Sogn og Fjordane (about 61° 18′ N., 4° E.). This turtle was in good condition and was probably also an adult: estimated length, about 2 metres; weight, 4,500 kgm. Repeated attempts to catch it failed.

J. F. Willgohs

Zoological Museum,
University of Bergen. Oct. 15.

Serum Amylase Activity: Normal Values

In a paper[1] on the determination of amylase activity in biological fluids, we suggested a temporary working 'normal' range of 9–35 of our units per 100 ml. of serum. This working range was derived from a study of the serum amylase activity of 101 hospital patients in whom there was no reason for suspecting an abnormal serum amylase activity.

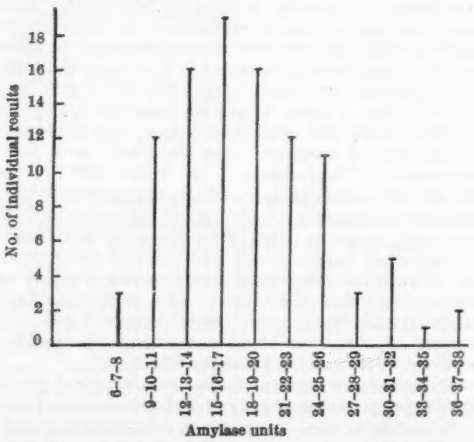

Fig. 1. Distribution curve of serum amylase activity in 100 'normal' healthy adult persons

We have now used our method[1] for determining the amylase activity of the serum of 100 'normal' healthy adult persons and the results have been examined statistically. The results range from 8 to 38 of our units, and the arithmetical mean is 19·47 of our units. 9 per cent of the results are less than 11 units, 8 per cent greater than 28 units; 3 per cent are less than 9 units and 2 per cent greater than 33 units.

Fig. 1 shows the distribution curve when the results are plotted in groups of three. The curve is skewed slightly to the right in the diagram.

The standard deviation is ± 6·84 and the coefficient of variation is ± 34·61. Twice the standard deviation on each side of the mean should, theoretically[2], leave out about 5 per cent of the number of results. 19·47 ± (2 × 6·84) gives 5·79 and 33·15, and these limits cut off 2 per cent of the results, both of which are above the upper limit. There are no results below 5·79. Three times the standard deviation on each side of the mean gives the limits of the curve as − 1·05 and + 39·99.

We suggest, therefore, that the 'normal' range of results for our method[1] is 6–33 of our units per 100 ml. of serum.

Work is now being carried out on an ultra-micro modification of our present method[1] and the procedure will shortly be published elsewhere.

Harold V. Street
John R. Close

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Department of Pathology,
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Manchester 8.

[1] Street, H. V., and Close, J. R., *Clinica Chimica Acta*, **1**, 256 (1956).
[2] Mainland, D., "The Treatment of Clinical and Laboratory Data" (Oliver and Boyd, London, 1938).

The Agama Lizard as Reservoir of *Salmonellae* in Nigeria

Bacteriological examination of the common agama lizard (*Agama agama*), which is plentiful in Ibadan, revealed that 18 of the 160 animals examined (11·2 per cent) were faecal carriers of *Salmonellae*. A variety of types were isolated, including *Salmonella elizabethville* (2), *S. kingston* (3), *S. durban* (1), *S. takoradi* (1), *S. kaapstad* (1), and a new type which has been assigned the provisional antigenic formula 4, 12 . . . i : 1, 6.

None of 100 house gekkoes (*Hemidactylus brookii*) were found to be carrying *Salmonellae*. To the best of our knowledge, lizards have not previously been recognized as a reservoir of *Salmonellae* in Nigeria, although Mackey[1] in East Africa, Lee and Mackennas[2] in Brisbane, and Hinshaw and McNeil[3] in California have published accounts of lizards as carriers of *Salmonellae*.

We should like to thank Dr. Joan Taylor, director of the *Salmonella* Reference Laboratory, Colindale, London, for her help in identifying these organisms.

A detailed account of our findings will shortly be published elsewhere.

Patrick Collard
David Montefiore

Department of Bacteriology,
University College,
Ibadan. Oct. 30.

[1] Mackey, J. P., *East Afr. Med. J.*, **31**, 1 (1955).
[2] Lee, P. E., and Mackennas, I. M., *Bull. Hyg.*, **30**, 1010 (1953).
[3] Hinshaw, W. R., and McNeil, E., *J. Bact.*, **52**, 349 (1946); **53**, 715 (1947); **55**, 870 (1948).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 21

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at the University, Manchester), at 5 p.m.—Prof. Clifford Holliday: "Anuradhapura, Sacred City of Ceylon" (Percival Lecture).

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Dr. D. J. D. Nicholas: "The Role of Metals in Enzymes with special reference to Flavoproteins".* (Further lectures on January 28, February 4 and 11.)

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (at 14 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. A. L. Abel: "Substituted Urea Compounds" (Weedkillers).

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. Joseph Needham, F.R.S.: "The Translation of Old Chinese Scientific and Technical Texts".* (First of three lectures on "Aspects of Translation". Further lectures on January 28 and February 4.)

INSTITUTE OF WOOD SCIENCE (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6.30 p.m.—Prof. F. W. Jane: "Wood Science—Its Past, Present and Future".

ROYAL INSTITUTE OF CHEMISTRY (at Enfield Technical College, Queensway, Ponders End), at 7.30 p.m.—Dr. R. H. Herz: "The Use of Photography in Scientific and Engineering Investigations"

Tuesday, January 22

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. R. Newth: "Regeneration in Animals".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Dr. A. A. Ahmed: "Recent Developments in Nile Control".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. McIlwain: "Neurochemistry".* (Fifth of fifteen lectures on "The Scientific Basis of Medicine", organized by the British Postgraduate Medical Federation.)

UNIVERSITY OF LONDON (at the Royal College of Science, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. J. G. Ball: "Metallurgy—Art, Technology, Science".

Wednesday, January 23

MEDICAL RESEARCH COUNCIL (at the National Institute for Medical Research, Mill Hill, London, N.W.7), at 5 p.m.—Dr. Robley C. Williams (University of California, Berkeley): "Electron Microscopic Studies of Virus Structure".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. J. G. Skellam and Dr. L. R. Shenton: "Distributions Associated with Random Walk and Recurrent Events".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Dr. I. G. C. Dryden: "The Chemistry of Coal and Its Relation to Coal Carbonization".*

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Papers on "Transistor Applications".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL (at 14 Belgrave Square, London, S.W.1), at 6.15 p.m.—Dr. L. E. Campbell and Mr. C. A. Adams: "Food Technology in Under-Developed Countries".

SOCIETY FOR ANALYTICAL CHEMISTRY, BIOLOGICAL METHODS GROUP (at "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Annual General Meeting, followed by a discussion on "The Relationship Between Statistics and Microbiological Assay".

BRITISH GLACIOLOGICAL SOCIETY (joint meeting with the CHALLENGER SOCIETY, at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 8 p.m.—Meeting on "Polar Ice". Mr. T. E. Armstrong: "The Ice of the Arctic Ocean"; Mr. H. F. P. Herdman: "The Antarctic Pack-ice".

Thursday, January 24

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. E. H. Linfoot and Dr. G. Black: "Spherical Aberration and the Information Content of Optical Images"; Dr. E. Bovey: "Some Optical Cements—Their Constitutions, Properties and Limitations"; Dr. R. N. Wilson: "Some Measurements on Absorption and Scattering of Optical Cements".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 6.45 p.m.—Symposium on "The Trans-Atlantic Telephone Cable". (Joint meeting, linked by the cable, with the American Institute of Electrical Engineers, and the Engineering Institute of Canada.)

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Theatre, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. M. L. Parsey: "Detection and Measurement of Vibration".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. E. J. Zaimis: "Factors Influencing the Action of Neuromuscular Blocking Substances".* (Sixth of fifteen lectures on "The Scientific Basis of Medicine", organized by the British Postgraduate Medical Federation.)

PRESTRESSED CONCRETE DEVELOPMENT GROUP (at the Institution of Civil Engineers, 5 Great George Street, London, S.W.1), at 6 p.m.—Mr. A. S. G. Bruggeling (Netherlands): "Progress of Prestressed Concrete".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Birdcage Walk, London, S.W.1), at 6 p.m.—Prof. H. J. van der Maas: "Aeronautical Research in Holland".

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Diagnosis of Mechanical Troubles".

INSTITUTE OF BIOLOGY (at 41 Queen's Gate, South Kensington, London, S.W.7), at 7.30 p.m.—Prof. C. H. Waddington, F.R.S.: "Gene Expression in Development".

Friday, January 25

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION AND INTERNAL COMBUSTION ENGINE AND LUBRICATION GROUPS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. P. de K. Dykes: "An Investigation into the Mechanism of Oil Loss Past Pistons"; Prof. O. A. Saunders and Dr. S. Eilon: "A Study of Piston Ring Lubrication".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.45 p.m.—Annual General Meeting. 7.15 p.m.—Scientific Papers.

Saturday, January 26

BRITISH PSYCHOLOGICAL SOCIETY (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Miss Gertrude Keir: "A Peripatetic Psychologist in America".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 3 p.m.—Mr. E. G. Sterland: "Some Highlights in the History of Mechanical Engineering".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH ASSISTANT IN GEOLOGY to work in the Department of Geology at Durham on pollen analysis of moorland peats of the Northern Pennines—The Secretary, The University, 38 North Bailey, Durham (January 26).

ASSISTANT, Grade B (suitably qualified graduate), IN CHEMISTRY—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (January 31).

ASSISTANT IN ZOOLOGY (ENTOMOLOGY)—The Secretary of University Court, The University, Glasgow (January 31).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Liverpool (February 2).

EXPERIMENTAL OFFICER at Ditton Laboratory (D.S.I.R.), near Maidstone, Kent, for engineering and physical problems of refrigeration applied to food preservation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.359/6A (February 2).

CHAIR OF PHILOSOPHY—The Secretary, The University, Exeter (February 9).

CHIEF CHEMIST (with a degree in chemistry and experience in spectrographic analysis, and preferably with experience in the analysis of ores and silicates) IN THE GEOLOGICAL SURVEY DEPARTMENT, Southern Rhodesia Government—The Public Services Attaché, Rhodesia House, 429 Strand, London, W.C.2 (February 9).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours in geology with experience in geological mapping in Colonial territories or under similar conditions abroad, coupled with experience in photogeological techniques) IN THE PHOTOGEOLOGICAL SECTION, Directorate of Colonial Geological Surveys, Tolworth, Surrey, for geological interpretation of aerial photographs and construction from them of geological maps—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting Ref. G.433/6A (February 9).

STAFF TUTOR IN NATURAL HISTORY in the Department of Extra-Mural Studies—The Secretary, The Queen's University, Belfast (February 15).

ASSISTANT LECTURER or LECTURER IN APPLIED MATHEMATICS—The Registrar, University College, Singleton Park, Swansea (February 18).

ASSISTANT LECTURER (with a special interest in physical chemistry) IN CHEMISTRY—The Registrar, The University, Manchester 13 (February 18).

LECTURER (preferably interested in the experimental aspects of ecology or taxonomy) IN BOTANY in St. Salvator's College—Joint Clerk to the University Court, College Gate, St. Andrews (February 18).

LECTURER (with a degree in science with geology as a major subject) IN GEOLOGY, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 18).

LECTURER (with research experience in aeronautics, preferably in the field of high speed aerodynamics) IN AERONAUTICAL ENGINEERING—The Secretary, The Queen's University, Belfast (February 20).

LECTURER IN MATHEMATICS at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 22).

LECTURER/SENIOR LECTURER (preferably with interests in power engineering) IN ELECTRICAL ENGINEERING, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 23).

I.C.I. RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary of University Court, The University, Glasgow (February 28).

LECTURER (with a degree in agriculture, engineering or agricultural engineering) IN AGRICULTURAL ENGINEERING at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 28).

MAURICE BLOCH MEDICAL RESEARCH FELLOW for research in the field of virology, with particular reference to poliomyelitis—The Secretary of University Court, The University, Glasgow (February 28).

PROFESSOR OF HEAVY CURRENT ELECTRICAL ENGINEERING at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, February 28).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOW IN PHYSICS, CHEMISTRY, ENGINEERING, METALLURGY and PHARMACOLOGY or any related subject—The Registrar, The University, Liverpool (March 1).

LECTURER or SENIOR LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING, University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Tasmania, March 1).

PROFESSOR OF EDUCATION at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, March 1).

ASSISTANT or ASSOCIATE PROFESSOR OF GEOPHYSICS—Head of the Department of Physics, University of British Columbia, Vancouver 8, British Columbia, Canada.

ASSISTANT PROFESSOR (with first-rate academic qualifications and able to speak French) OF EMBRYOLOGY AND HISTOLOGY—The Chairman, Department of Biology, Université de Montreal, Montreal 26, Canada.

CHEMICAL OR PETROLEUM ENGINEER (with high academic qualifications (Ph.D. or equivalent), and preferably some experience in refinery or pipeline operation), to take charge of pilot plant studies concerned with the flow of liquids and granular solids; a CHEMICAL or MECHANICAL ENGINEER (with high academic qualifications (Ph.D. or equivalent), and preferably experience or interest in coal technology), to take charge of a varied programme of pilot plant studies (briquetting, combustion, fluidized carbonization, solvent extraction, etc.); and JUNIOR ENGINEERS—The Secretary, Research Council of Alberta, 87th Avenue and 114th Street, Edmonton, Alberta, Canada.

GRADUATE (man or woman, with a knowledge of microbiology, and preferably with a knowledge of, or willing to learn, foreign languages, especially German and Scandinavian), to join a team on information work and abstracting connected with dairying—The Director, Commonwealth Bureau of Dairy Science and Technology, Shinfield, Reading.

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING; SENIOR LECTURER IN HIGH POLYMER TECHNOLOGY; and a SENIOR LECTURER IN APPLIED PHYSICS, at the College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

LECTURER or GRADE B ASSISTANT IN PHYSIOLOGY IN THE DEPARTMENT OF BIOLOGY—The Registrar, College of Technology and Commerce, Leicester.

LECTURER (with experience in bacteriology and/or virology) IN BACTERIOLOGY—The Registrar, The University, Bristol.

SENIOR LECTURER or LECTURER IN GEOGRAPHY; and a LECTURER IN GEOLOGY, at Makerere College (The University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

SENIOR TECHNICIAN (with experience in preparing medical and dental student pharmacological experiments, capable of general maintenance of departmental equipment and assisting with physiological or biochemical research)—The Chairman, Department of Pharmacology, McGill University, Montreal, Canada.

TECHNICIAN or STUDENT TECHNICIAN IN THE BIOCHEMISTRY DEPARTMENT—Dr. Walker, Royal National Orthopædic Hospital, Stanmore, Middlesex.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Agricultural Research Institute of Northern Ireland. Twenty-ninth Annual Report, 1955–56. Pp. 44. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1956.) [2011

Forestry Commission. Thirty-sixth Annual Report of the Forestry Commissioners for the year ended 30th September, 1955. Pp. 90+4 plates. (London: H.M. Stationery Office, 1956.) 4s. 6d. net. [2011

Sixth Report from the Committee of Public Accounts, Session 1955–56. Pp. 36. (London: H.M. Stationery Office, 1956.) 1s. 6d. net. [2011

The Agricultural Significance of the Hills. By B. R. Davidson and G. P. Wibberley. (Studies in Rural Land Use, Report No. 3.) Pp. iv+63. (Wye, Ashford, Kent: Wye College, 1956.) 5s. [2011

Overseas Vacancies Register. Pp. 1+12. (London: United World Education and Research Trust, c/o National Peace Council, 1956.) 2s. 6d. [2111

Colonial Office. Fishery Publications No. 7, 1955: Recent Developments in the Barbadian Flying-Fish Fishery and Contributions to the Biology of the Flying-Fish *Hirundichthys Affinis* (Günther 1866). By D. N. F. Hall. Pp. ii+41+4 plates. (London: H.M. Stationery Office, 1956.) 11s. 6d. net. [2111

Colonial Geology and Mineral Resources: Supplementary Series. Bulletin Supplement No. 1: The East African Rift System. By Dr. F. Dixey. Pp. iv+71+7 plates. (London: H.M. Stationery Office, 1956.) 7s. 6d. net. [2111

Report of the Conference on Recent Developments in Cloud-Chamber and Associated Techniques, comprising collected papers of the conference held under the joint auspices of the Physical Society of London and University College London, in March 1955. Edited by N. Morris and M. J. B. Duff. Pp. vi+227. (London: University College, 1956.) 30s. [2211

Department of Scientific and Industrial Research. Overseas Technical Reports No. 2: Chemical Engineering in the U.S.A.—Some Observations Resulting from a Survey made in 1955. By Dr. P. H. Calderbank. Pp. vi+24. (London: H.M. Stationery Office, 1956.) 2s. net. [2211

Eighth Annual Report of the Advisory Council on Scientific Policy (1954–1955). (Cmd. 9537.) Pp. iv+12. (London: H.M. Stationery Office, 1956.) 6d. net. [2311

University Grants Committee. Methods used by Universities of Contracting and Recording and Controlling Expenditure. (Cmd. 9.) Pp. 46. (London: H.M. Stationery Office, 1956.) 2s. net. [2311

Building Research Station Digest. No. 93 (October 1956): A Comparison of Capital Costs of Heating Systems in Houses. Pp. 8. (London: H.M. Stationery Office, 1956.) 3d. [2311

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1956. No. 4: Furfural from Agricultural Sources: Production and Chemistry. By Andrew P. Dunlop. Pp. ii+17+6 plates. (London: Royal Institute of Chemistry, 1956.) 4s. net. [2311

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for 1955. South Western Division. By T. A. Jones. Pp. ii+24+2 plates. 2s. 6d. net. East Midland Division. By W. B. Brown. Pp. ii+42+7 plates. 3s. net. (London: H.M. Stationery Office, 1956.) [2311

Ministry of Agriculture, Fisheries and Food. Bulletin No. 136: Watercress Cultivation. Second edition. Pp. iv+28+4 plates. (London: H.M. Stationery Office, 1956.) 2s. 6d. net. [2311

Other Countries

United States Department of the Interior: Geological Survey. Water-Supply Paper 1250: Quality of Surface Waters of the United States 1952. Parts 1–4: North Atlantic Slope Basins to St. Lawrence River Basin. Prepared under the direction of S. K. Love. Pp. xi+365. 1.25 dollars. Water-Supply Paper 1272: Surface Water Supply of the United States 1953. Part 1–B: North Atlantic Slope Basins, New York to York River. Prepared under the direction of J. V. B. Wells. Pp. xi+535. 1.75 dollars. Water-Supply Paper 1328: Ground-Water Resources of the Hopkinsville Quadrangle, Kentucky. By Eugene H. Walker. Pp. iv+98+4 plates. 70 cents. Water-Supply Paper 1333: Surface Water Supply of the United States 1954. Part 2–A: South Atlantic Slope Basins, James River to Savannah River. Prepared under the direction of J. V. B. Wells. Pp. viii+314. 1.25 dollars. Water-Supply Paper 1356: Geology and Ground-Water Resources of the Henderson Area, Kentucky. By Edward J. Harvey. Pp. v+227+13 plates. n.p. Professional Paper 300: Contributions to the Geology of Uranium and Thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations International Conference of Peaceful Uses of Atomic Energy, Geneva, Switzerland, 1955. Pp. vii+739+17 plates. n.p. (Washington, D.C.: Government Printing Office, 1956.) [1511

United States Department of Commerce: Weather Bureau. Forecasting Guide No. 1: Forecasting Tornadoes and Severe Thunderstorms. Edited by Jay S. Winston. Pp. v+34. (Washington, D.C.: U.S. Department of Commerce, Weather Bureau, 1956.) [1511

Anuario del Observatorio Astronómico de Madrid para 1957. Pp. 395. (Madrid: Observatorio Astronómico, 1956.) [2011

Bulletin of the Florida State Museum, Biological Sciences. Vol. 1, No. 4: Two New Species of *Philogenia* from the Panama Canal Zone (Odonata: Coenagriidae). By Roger B. Cumming. Pp. 241–252. (Gainesville, Fla.: University of Florida, 1956.) [2011

Kungl. Skogshögskolans Skrifter. (Bulletin of the Royal School of Forestry, Stockholm.) Nr. 24: The Distribution of Watersoluble Radioactive Substances in Plant Tissue—Some Experiments with an Autoradiographic Method. By E. Wikberg. Pp. 11. 1 kronor. Nr. 25: Marktemperaturen i Ytsteniga Jordarter. Av Tryggve Troedsson. Pp. 22. 3 kronor. (Stockholm: Skogsbibliotheket, Skogshögskolan, 1956.) [2011

Smithsonian Miscellaneous Collections. Vol. 131, No. 10: Crustacean Metamorphoses. By R. E. Snodgrass. Pp. iii+78. (Washington, D.C.: Smithsonian Institution, 1956.) [2111

The Constitution of Matter. By Robert Oppenheimer. (Condon Lecture.) Pp. vii+37. (Eugene, Oregon: Oregon State System of Higher Education, 1956.) 1 dollar. [2111

University College, Ibadan, Nigeria. Calendar, 1956–57. Pp. 64. (Ibadan: University College, 1956.) [2211

Northern Region of Nigeria. Annual Report on the Forest Administration of the Northern Region of Nigeria for the year 1954–55. Pp. ii+31. (Kaduna: Government Printer; London: Crown Agents for Oversea Governments and Administrations, 1956.) 9d. [2211

Canada: Department of Northern Affairs and National Resources. National Museum of Canada. Bulletin No. 142: Annual Report of the National Museum of Canada for the fiscal year 1954–55. Pp. vi+180 (20 plates). (Ottawa: Queen's Printer, 1956.) 1.50 dollars. [2211

New South Wales University of Technology. Calendar, 1956. Pp. 446. (Kensington, N.S.W.: New South Wales University of Technology, 1956.) [2211

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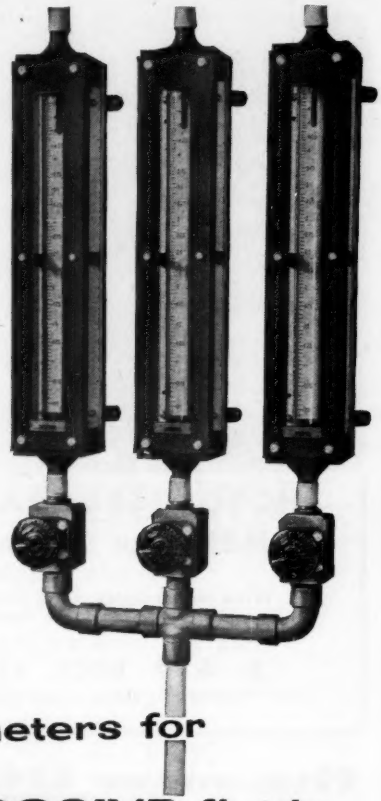

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Measurement and control of corrosive fluids are vital in modern chemical engineering, but the measuring instruments employed must be fully resistant to attack. The Rotameter flowmeter is ideal for this purpose. The simplicity of design of the basic metering unit lends itself to construction in a combination of non-corrosive materials—glass, ceramics, plastics, stainless steel or noble metals—enabling a flowmeter to be provided for every known variety of corrosive liquid or gas, even at extremes of temperature and pressure.

The illustration shows a Rotameter installation on a chlorine solution distributor with all non-metallic contact parts (glass, ceramic, plastic and rubber).

Catalogue RP2000/N gives details of ROTAMETER flowmeters and includes density meter and level indicator

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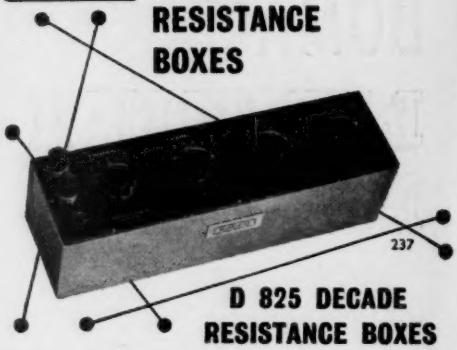

D 825 DECADE RESISTANCE BOXES

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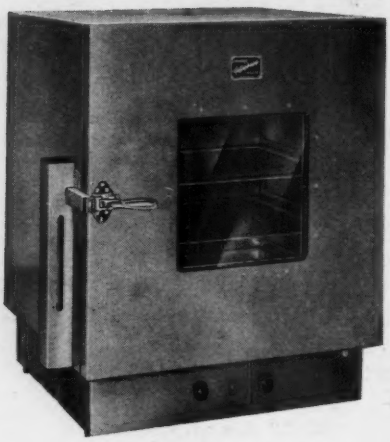

★ *6 cu. ft. capacity* ★ *up to 50°C.* ★ *up to 90% R.H.*

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★ *Small temperature variation throughout working space (less than 1° C.).*
★ *Air-tight—good humidity control.*
★ *Rapid recovery of temperature and humidity after opening door.*
★ *Sturdy enamelled steel case with tinned copper liner.*
★ *Good air circulation by induction motor-driven fan.*
★ *Rigorous specification of all parts ensures high performance and excellent reliability.*

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